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A CONVENIENT METHOD FOR THE PREPARATION OF AQUEOUS HYDROBROMIC ACID OF CONSTANT BOILING POINT.

By J. G. F. Druce, M.Sc., A.I.C.

It is well known that when concentrated suplhuric acid is added to potassium bromide, the hydrobromic acid gas evolved is not pure, since the concentrated sulphuric acid exerts an oxidising action upon it, liberating some free bromine, and being partly reduced to sulphur dioxide.

Thus it is not possible to prepare pure hydrobromic acid by the interaction of sulphuric acid and potassium bromide unless a reducing agent of some kind is added to prevent the oxidation of the hydrogen bromide formed.

Pickles (*The Chemical News*, 1919, CXIX., 89) has described a very simple method for obtaining a strong aqueous solution of the acid free from bromine and sulphur dioxide by the distillation of a mixture of concentrated sulphuric acid (3.4 cc.) and potassium bromide (15 grams) dissolved in 25 cc. of water, to which a trace of stannous chloride (0.2 gram) has been added.

In repeating this work, it was found that a distillate began to come over at 103° C., and the temperature did not rise to 120° C. (the boiling point of the strongest solution of constant B.P.) until most of the aqueous hydrobromic acid had passed over. The distillation was also accompanied by much "bumping," which was not arrested by the introduction of pieces of broken glass or porous pot.

Much more satisfactory results were obtained by increasing the quantity of sulphuric acid to 10 cc., which was added to the 15 grams of potassium bromide dissolved in 25 cc. of water containing 0.2 gram of stannous chloride. The mixture was allowed to stand overnight, so that much potassium hydrogen sulphate crystallised out.

The supernatant liquid was decanted from the crystals and distilled. Nearly all the distillate came over at 120-125°. The temperature rose rapidly to 120°, and then very gradually to 125°, 18 cc. of distillate were collected between these two temperatures.

In order to determine the exact yield of hydrobromic acid by this method, ten cc. of the distillate were made up to 250 cc. with distilled water, and quantities of 10 cc. were withdrawn and titrated with 0.2 normal potassium hydrate solution, using phenolphthalein as indicator.

It was found that 12.05 cc. of the alkali solution were required to neutralise 10 cc. of the diluted hydrobromic acid solution.

Thus this diluted acid contained 19.48 grams of hydrogen bromide per litre, and this indicates that the original distillate contained 48.7 per cent. of hydrobromic acid gas.

Since stannous chloride was used in the preparation of the hydrobromic acid, a trace of hydrochloric acid (not more than 0.07 gram) might be present in the product.

But disregarding this negligible amount, the yield of hydrobromic acid was thus over 90 per cent. of that which it is theoretically possible to obtain.

MISSING ELEMENTS IN THE PERIODIC TABLE.

Part III.

By F. H. Loring.

A study of the above subject (see *Chemical News*, Nov. 24, 1922, vol. CXXV., p. 309; and Dec. 29, vol. CXXV., p. 386) leads to some exceedingly interesting observations in connection with the relative quantitative production of the chemical elements. It will not be out of place, therefore, to discuss the matter further.

The existence of scandium in the sun, and it may be present there in considerable relative quantities, does not necessarily invalidate the view advanced, namely, that this element may not exist in relatively large quantities compared with that of its neighbours, because, according to recent speculations, the stars are manufacturing elements out of hydrogen, and any element, for example scandium, appearing in relative excess during the process of manufacture or element evolution, may not ultimately remain in the same quantities. The following quotation from Aston's book, "Isotopes" (1922), p. 103, bears upon this subject:—

"It has long been known that the chemical atomic weight of hydrogen was greater than one quarter of that of helium, but so long as fractional weights were general there was no particular need to explain this fact, nor could any definite conclusions be drawn from it. The results obtained by means of the mass-spectrograph remove all doubt on this point, and no matter whether the explanation is to be ascribed to packing or not, we may consider it absolutely certain that if hydrogen is transformed into helium a certain quantity of mass must be annihilated in the process. The cosmical importance of this conclusion is profound, and the possibilities it opens for the future very remarkable, greater in fact than any suggested before by science in the whole history of the human race.

"We know from Einstein's Theory of Relativity that mass and energy are interchangeable (Eddington, 'Time, Space and Gravitation,' p. 146), and that in C.G.S. units a mass m at rest may be expressed as a quantity of energy mc^2, where c is the velocity of light. Even in the case of the smallest mass this energy is enormous. The loss of mass when a single helium nucleus is formed from free protons and electrons amounts in energy to that acquired by a charge e falling through a potential of nearly thirty million volts. A swift α ray has an energy of three to four million volts, so that the change of packing suggested by Brösslera need not be nearly so great to provide the energy needed. If instead of considering single atoms we deal with quantities of matter in ordinary experience, the figures for the energy become prodigious.

"Take the case of one gramme atom of hydrogen, that is to say, the quantity of hydrogen in 9 cc. of water. If this is entirely transformed into helium the energy liberated will be

$$0.0077 \times 9 \times 10^{20} = 6.93 \times 10^{18} \text{ ergs.}$$

Expressed in terms of heat this is 1.66×10^{11} calories, or in terms of work, 200,000 kilowatt hours. We have here at least a source of energy sufficient to account for the heat of the sun (Eddington, *Brit. Assoc. address*, 1920; Perrin, *Scientia*, Nov., 1921). In this connection Eddington remarks that if only 10 per cent. of the total hydrogen on the sun were transformed into helium, enough energy would be liberated to maintain its present radiation for a thousand million years.

"Should the research worker of the future discover some means of releasing this energy in a form which could be employed, the human race will have at its command powers beyond the dreams of scientific fiction; but the remote possibility must always be considered that the energy once liberated will be completely uncontrollable, and by its intense violence detonate all the neighbouring substances. In this event the whole of the hydrogen on the earth might be transformed at once, and the success of the experiment published at large to the universe as a new star."

It is not quite clear how this energy cycle would work. When, for example, small quantities of H_2 and O_2 are exploded to form water (H_2O) great heat is given out, but to explode water and get the energy back is impossible; for it is not given to us twice over. If the formation of the elements in the sun is due to the combination of protons and electrons taking place, how can we expect to get back heat already given away in the form of radiation? This is not probably the true interpretation of the above-quoted statement. It is assumed that if the hydrogen contained in the waters of the earth were united by some temperature and pressure condition as obtaining in the sun, the heat evolved would reduce the earth to a molten mass like the sun. However this may be, if this idea can be harmonised with radioactivity, it would be more acceptable; in which case one would have to assume that there are independent or free protons in the structure of the radio-element (very much as there are free electrons oscillating or revolving round a nuclear part), which combine explosively to form helium, but such explosions do not seem to extend to adjoining protons, for radio-activity is only concerned with a part of the whole atom—and therein, perhaps, lies our safety.

At one time it was roughly estimated that there were 50 million stars (suns). These, whatever their number may be, vary in size and temperature, so that the physical condition favourable to the production or degradation of different elements in varying quantities may also vary. Assuming that these at one time or another become most active in the production of elements, the quantitative production per star might vary considerably; in short, there would be many variables.

Other views than the above with regard to the origin of the excessive heat of the

sun have been advanced. Prof. Joly (*Nature*, 1922, vol. CX., p. 112) has recently suggested that the sun's heat is due to temperature and pressure effects stimulating radio-activity in practically all the elements favourably situated in this respect. This idea was discussed at considerable length in my "Atomic Theories" (1921), chapter XXI.

Sir Wm. Crookes' theory of the evolution of the elements is of interest in this connection. Quoting again from Aston's book, page 117, he says: "A more attractive theory than the one given above [that *all* the elements are the result of radio-active disintegrations, but these radio-changes were continued beyond the ordinary limit observed at present] is that the complex atoms of matter have been evolved by the aggregation of simpler atoms. This idea has received a good deal of attention in the past. Crookes (*Brit. Assoc. address*, 1886) remarks on it as follows:—'Let us picture the very beginnings of time, before geological ages, before the earth was thrown off from the central nucleus of molten fluid, before even the sun himself had consolidated from the original *protyle*. Let us still imagine that at this primal stage all was in an ultra-gaseous state, at a temperature inconceivably hotter than anything now existing in the visible universe; so high indeed that chemical atoms could not yet have been formed, being still far above their dissociation point. In so far as *protyle* is capable of radiating or reflecting light, this vast sea of incandescent mist, to an astronomer in a distant star, might have appeared as a nebula, showing in the spectroscope a few isolated lines, forecasts of hydrogen, carbon, and nitrogen spectra.

"'But in due course of time some process akin to cooling, probably internal, reduces the temperature of the cosmic *protyle* to a point at which the first step in granulation takes place; matter as we know it comes into existence, and the atoms are formed.'"

"This vivid picture [of Crookes] may be brought up to date by substitution of free protons and electrons for the hypothetical protyle. We can imagine regions containing matter where the temperature is so high that not only is the dissociation of atoms from atoms and nuclei from planetary electrons complete, but also protons and electrons are in a state of agitation so violent that even the most stable nuclei cannot be formed. We should have here matter of the simplest form we can imagine, or rather of no form at all, simply more or less neutral electric gas. Such a condition is by no means impossible in our universe and may actually occur during one of those excessively violent catastrophes occurring in far-distant space and observed by us as a new star.

"By some such cooling process as that suggested by Crookes we easily imagine the free charges combining to form the nuclei of elements. Whether those of heavier elements are formed direct by the charges getting into particular geometrical relations with each other, or whether helium nuclei are formed first and then subsequently coalesce depends on which theory of nuclear structure is adopted. In any case vast quantities of energy will have to be radiated off, and this radiation may be of such extremely high frequency that it is capable of disrupting nuclei themselves, so that there might be at this stage rapid and continuous transformations from heavier to lighter nuclei and *vice versa*.

"For the present we are interested in the number of each type of atom which survives. It is obvious that if the conditions of cooling are practically identical throughout the whole mass, there is no reason why the composition of the matter produced should vary. If 3 atoms of Cl35 are formed to every 1 of Cl37 at any one point, the same ratio must hold at every point so that a complex [composite] element of constant atomic weight will be formed. But it is much more likely that different parts of this primordial mass will undergo their transformations under different rates of cooling, etc., so it is worth while inquiring if variation in the mean atomic weight of a complex element is to be expected.

"The quantity of one particular atomic nucleus formed will probably depend (*a*) on the probability of a certain configuration of charges happening as a chance event; (*b*) the stability of the particular nucleus formed as the result of that event. Again, to take the case of chlorine, each isotope may be regarded as completely stable, and the relative quantities formed will simply depend on condition (*a*). Now it is not unreasonable to suppose that this is not seriously affected by different rates of cooling, and in this case the isotopes will be evolved in constant proportion. As we know of no natural process by which the proportion of isotopes can be altered appreciably, the complex elements will have to

day the same chemical atomic weight as when they were first formed.

". . . If the matter forming the earth went through a primordial stage such as that suggested above, it certainly did so more than 10^9 years ago. It follows that of the radio-active elements then formed, only two, thorium and uranium, will now be found on the earth, for the other radio-active elements existing to-day are of such a short period that they must have been formed since. Hence we may divide the *original* elements very simply and definitely into two groups: (1) All the stable; (2) Thorium and Uranium, whose nuclei are so complex that they are only partially stable."

This is all very interesting and more or less relevant to the subject under consideration; but, of course, extensive quotation widens the subject beyond the scope of the present argument. It is the aim, however, to punctuate these papers with interesting matter apart from the particularly novel features presented.

Problems of the kind involved in these studies are very difficult of proper solution, but converging lines of investigation often focus different observations into one common one, and thereby establish quantitative relations which can be accepted as being substantially true. It is important to keep in mind that each line of study may lead to some definite scientific or technical fact of permanent value, though at first it appears strange and contrary to common experience.

SUMMARY.

The existence of scandium in the sun does not necessarily invalidate any relative quantitative deduction as to the proportionate amounts of this element relative to that of those on each side of it in the atomic-number series, for the sun may be manufacturing or degrading practically all the eixsting elements, and any excess of one in particular may not appear in large relative quantities in the final state when this process of manufacture and degradation is finished. Quotations from Aston's book, "Isotopes," are given in general support of the argument. It is incidentally suggested that the danger of the hydrogen on the earth exploding to form helium, etc., is not probable; for if this theory be true in principle, then probably the energy of radio-changes, involving the expulsion of an alpha particle, is derived from the explosive combination of four protons to form helium; but, since other protons in the atom are not exploded at the same time, the process is of a very prescribed nature—and therein perhaps lies our safety.

CORRECTIONS.

In Part I. of this series, p. 309, the bracket under VIII. should be extended to embrace the numbers 8, 9, and 10. In Periodic Table, same page, "S" should read "Si"; and the bracket at RaF should be turned the other way. On p. 310, left-hand column, 27th line from bottom of page ," Cs" should read "Rb." On p. 311, under Table III., "UX_2" should read "UX2" for sake of uniformity.

THE COLOURING OF METALS.

A meeting of the Birmingham and Midland Section of the Society of Chemical Industry was held at the University of Birmingham, on Tuesday, Dec. 19, Dr. Maxted in the chair. There was a very large attendance of industrial chemists and metallurgists.

Mr Alex. E. Tucker, F.I.C., read a paper on "The Colouring of Metals"—iron, steel, copper, and brass. He stated that with a given action of reagents, with or without external currents, the colour produced is a function of the time of the action. In speaking about the importance of current in bringing about the results, it will be admitted that all such actions where reagents affect the surface of the metal are in the ultimate meaning of the term, essentially electrical; in the process described, there is every indication of electrical cause and effect, though in one process external current is not used. The simplest illustration is that of the immersion of an iron or zinc surface in copper sulphate; copper is deposited. Again, if a piece of pickled zinc is immersed in a weak solution of copper tartrate and caustic soda, the colouring is slow, and may be arrested at any stage from a violet to steel blue, green, orange, yellow to purple red. Doubtless the action is entirely an electrical one, and the colour depends upon the thickness of the affected surface, but zinc castings may be bronzed by treating them with a mixture of ammonium chloride, potassium oxalate, and vinegar. Here, there is apparently no metal capable of being deposited, and the effect would appear to be due entirely to the altered sur-

face of the zinc and its consequent effect on vision. A considerable range of effects can also be obtained by heating metals to certain temperatures, thus obtaining a variety of coloured oxides, and this range may be extended if they are first coated with certain reagents, which need not necessarily be of metallic character. A cheap and extensively used method of blacking iron and steel goods is to heat them to a high temperature and to plunge them in oil. A superficial carbonising of the oil results, which for many purposes is quite satisfactory for rough articles; on the other hand, it is obvious that such heating is not permissible when hardness of surface is required. The process of blacking and tempering will not often go together, and the process is too crude. The well-known appearance of best gun bronzing is got by the rusting of the barrels, the ends being plugged; this rust is converted into the black oxide of iron by boiling the barrels in water through which air is passing; they are then mopped to remove the loose oxide, and they are again rusted and boiled. These processes are repeated many times in the best work, after which the work is oiled. The commoner bronzing of gun barrels is done with compounds of antimony. It is easy to produce fine effects by all colouring processes, provided the work is originally polished, indeed it is hopeless to treat any but the best surfaces—hence the common use of coloured varnish or even paint when such polishing is absent.

The author explained and gave demonstrations of new electrolytic processes—the Sentini Rondelli processes—in which no foreign metal is used for obtaining the colours, these depending on the alteration only of the surfaces of metals of which the goods are made. There are four processes in practical operation: (1) Dull black oxidising process, by means of which iron, steel, and cast iron parts may be oxidised a dull black. (This process, electrolytic in nature, also includes the derusting of iron, steel, and cast iron parts, and their preparation for enamelling, painting, etc.); (2) colour oxidising process, by which iron, steel, cast iron, and malleable iron parts may be oxidised in various colours, from an imitation of yellow brass to a dark brown colour; (3) copper on brass oxidising process, which is similar to process (1), but which provides for the oxidation of copper to a dull black, capable of being polished to a shiny black, and very resistant to chemical action; (4) the shiny black oxidising process, by which steel and cast iron parts may be oxidised to a brilliant black. (No current is required, and the oxidation is complete in a few minutes.) Acetylene welded tanks are used, as it is found that rivetted tanks will not stand the strong soda solutions and repeated heating and cooling. These tanks are heated by gas, and are electrically insulated in order to economise the heavy currents used.

Regarding to process (1), the author pointed out that the first requirement is to produce a sodium ferrite in the bath as the electrolyte. This may be readily formed by using a sheet of iron a little less in area than the long side of the bath as an anode in a caustic soda solution, and using a current of about 45 amps. for each square foot of the sheet; on reversing the current every few minutes for about an hour, a ferrite of soda is formed, and the bath is ready for prodoction work. Tht progressive dissolution of the iron is shown by the reading of the voltmeter. At the beginning the voltage stops at a point under 1 volt for a very short time before reaching the stable value of about two volts. This is a direct reading of the polarisation phenomenon, and the intensity of this polarisation increases as the formation of the sodium ferrite increases. A good bath requires at a current density of 5 amps. per sq. dm. 2 or 3 minutes' depolarisation period. The colour and copper oxidising processes are simply variations of the conditions of working the above solutions. The shiny black oxidising process is entirely different, in that no current is used, the oxidation being effected by using an alkaline bath containing an oxide of a metal having electric negative behaviour relative to the iron, so as to produce oxidation of the iron surface with separation of the metal of the oxide used.

Mr. Tucker pointed out that the ferrites and ferrates of the alkalies may be regarded as compounds of the type $Na\,Fe\,O_2$ or $Na_2\,Fe_2\,O_4$, in which the ferric oxide acts as an acid radical. The ferrate, on the other band, is a name given to the compounds of the type $Na_2\,FeO_4$, and which correspond to a ferric peroxide FeO_3 and the hypothetical ferric acid $H_2\,FeO_4$. It would appear that under the action of the powerful currents used, entirely different compounds must be formed; it would seem that the ferrite on which the processes depend corresponds to the formula $Na_2\,FeO_2$,

and is a white-greenish body not easily obtained in the solid state.

Although the surface produced on the iron articles is the magnetic oxide Fe_3O_4, and therefore is not capable of absorbing oxide, it is unfortunately too true that the articles treated are not entirely rustproof. It would appear that the surface, like nickel plating, is porous to damp and carbonic acid, and therefore in such atmospheres they will rust slightly. On the other hand, the surfaces are more resistant to rusting than any other process, with the exception of the old Bower Barff process, that he knew of. But that process depended on the formation of a thick coating of magnetic oxide—so thick that it was brittle and pealed. At the end of the depolarising period, the e.d. at the poles of the cell rises considerably, and this point coincides with the formation of a stable film of magnetic oxide on the electrode, the solution of iron ceasing on the reaching of the true surface of the electrode. There is, therefore, no corrosion. Magnetic oxide, as resulting from the action of the bath on the rust, is very easily reduced by cathodic reduction to metallic iron.

The time taken for the oxidising period to be completed depends upon the concentration of the ferrite in the bath and the length of the negative period, but as a rule it is in the vicinity of three minutes. The total time for the complete derusting and oxidising of an average steel part is 10 to 12 minutes. In general, all cast iron, malleable iron, steel, and wrought iron parts can be successfully oxidised. Special steels, such as some chromium and tungsten alloys, show a tendency to oxidise to a brownish-black tinge, and not to a deep flat black. This tendency can be overcome by the prolongation of the reducing and oxidising periods, and by increasing the current flowing through the objects per sq. foot of area. The hardness of the coloured surfaces obtained is remarkable; they would stand any reasonable buffing, but not, of course, emery, etc.; the black oxide of copper surface is also remarkably hard, and is unaffected by sulphur from gas or rubber.

An interesting discussion followed, Professor T. Turner (Birmingham University), Dr. H. W. Brownsdon, Mr. Page (B.S.A. works), Mr. H. Silvester, and others taking part.

COLLOIDS IN GEOLOGIC PROBLEMS.*

By George D. Hubbard.[1]

(Continued from Page 395).

Colloids as Cements.

It has long been known that nothing soluble occurs in the shales to hold them together, and yet they are extremely resistant to pulling strains. We say their tensile strength is high. The ultra clay in shales and clays has been shown by ceramists to consist largely of hydrated aluminium silicates, such as kaolin and halloysite, also nontronite, iron hydroxides, silicic acid, organic matter, and possibly aluminium hydroxide. These in their finely divided state are all colloidal, and as binders they are stronger when dry than Portland cement. They are the cement of shales and the strength of some limestones. Colloidal silica also serves as a binder in many sandstones. It is known, too, that the silica cements now in the crystalline state were deposited in some cases in chalcedonic or colloidal condition.

In addition to this colloidal material in the shales, it is known that opaline silica, when subjected to the processes of metamorphism, loses its H_2O and becomes crystalline quartz in a mica schist. Clarke[13] shows that colloidal matter contained in most muds and clays is perfectly capable of binding under the influence of pressure alone, and believes that shales owe most of their coherence to unions of this sort. He states on page 609 that it is possible for colloidal silica and colloidal hydroxides of aluminium and iron to react and form new silicates when the shales are metamorphosed into schists. Thus these finely divided materials play their parts in the make-up of metamorphic products derived from the shales.

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* From the American Journal of Science, August, 1922, p. 95.

[1] The author is deeply indebted at many points in the paper to Dr. Harry N. Holmes, of Oberlin College, for suggestions and criticism. His General Chemistry and Colloid Manual have been of much help also. This paper was presented to the Geologic Section of the Ohio Academy of Science, April 15, 1922.

[13] Clarke, F. W., Data of Geochemistry, U.S.G.S. Bull., MCXVI., p. 545.

This process must be closely akin to the one going on in the process of binding the materials of our stone roads. Grout[14] and Cushman[15] have been carrying on experiments on the cements of roads, and they think their work shows rather conclusively that the binding power of road-making materials is due to substances in the colloidal state, developed by hydrolyzing the oxides, probably of calcium, iron, and aluminium, thus making the body more or less plastic. Subsequently by crystallisation and dehydration they become firm, making a solid road.

Adsorption and Mineral Colours.

Very much can be said on the subject of adsorption and colloids which is not geologic, but a number of points certainly belong in this paper at this place. Every surface has an attraction for other substances. This holding-to a surface is called adsorption. Glue on a board or in a beaker adsorbs board or glass, that is, there is a strong attraction between the surface of the one and the particles of the other.

Adsorption, then, probably explains some of the colours of minerals, inasmuch as the particles of the mineral crystal correspond to the surface of the wood or glass, and the colouring is in such minute particles as to be in the colloidal state. Examples of such intimate relationships are found in the carbon and iron oxide which give the smoky tint to cairngorm, and the carbon which is believed to be responsible for the colour of amethyst. Rose quartz owes its colour to the adsorption of colloidal titanium on its particles as they come together to build up the crystal, and chrysoprase is said to be coloured much in the same way by nickel oxide. Feldspars have long been believed to owe their colour to traces of iron oxide which seems to be adsorbed by the molecules of the feldspar.

The beautiful blue colour of some halite has been shown to be due to metallic colloidal sodium, and probably the bluish tint of sylvite may be traced to the same cause. The colours of barite are thought by Patten to be due to various oxides. He has shown that it adsorbs salts of nickel, cobalt, corhmium, iron and manganese. Calcite is practically never a colloid, but it shows rather high adsorptive powers for certain colloids. The amber calcite has been shown to be due to organic matter, and the amber fluorite is probably due to hydrocarbons. Ruby spinel seems to owe its beautiful tints to adsorbed chromium oxide, and cerussite in blues and greens to colloidal hydrous copper carbonate. More than likely, though this is not demonstrated, the soft tints of the zinc salts, calamine, and smithsonite, from Laurium, Greece, are due to the adsorption also of copper carbonates. The colours of many gems may probably be due to adsorption of some finely divided substance which becomes so intimately mixed with the gem materials, yet which occurs in such minute quantities, as almost to defy detection. This problem has only recently been taken up, and we may, as the work goes on, find much more in it than has yet been shown.

Colloids and the Flotation Process.[16]

While the flotation process now practised in many of our ore concentration plants is not really a geologic problem, it is so closely connected with geologic materials that I venture to call attention to it here.

In the last few years, many of our large concentration plants have installed elaborate facilities for flotation of ores. By the use of this process, the heavy sulphides are separated from the gangue minerals in what might be called a reverse gravity method, because the heavy ores come to the top and are from there removed, while the lighter materials go to the bottom of the medium. But gravity has nothing to do with the process. If galena be wetted with water, and a drop of oil be put upon it, the oil displaces the water. Galena adsorbs oil much more strongly than it does water. On the other hand, if oil be spread over a quartz or calcite crystal and a drop of water be put upon it, the oil is at once displaced by the water. In other words, water is adsorbed much better by these common gangue minerals than is the oil.

For flotation the mineral is finely ground, usually in a wet condition, fine enough to pass through a 48-mesh sieve. A very small amount of pine, or some other oil with air is beaten into the water, which already contains the pulp of ore and gangue.

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[14] *Grout, F. E., Journ. Am. Chem. Soc.*, 1905, XXVII., 1037.

[15] *Cushman, A. S., U.S. Dep. Agr., Bur. Chem., Bull.*, LXXXV., p. 92; *Trans. Am. Ceramic Soc.*, 1904, VI., 7.

[16] *Moses, F. C., Colloids and Flotation, U.S. Bur. Mines, Tech Paper CC furnishes many data for this section.*

The *beating must not go far enough to* make an emulsion or bring the oil into a colloidal state. The oily froth is made up of films of colloidal thinness, but is not emulsified. In this mixture the fine particles of sulphides adsorb the oil because it *wets their sufraces, float to the top* by means of their little coats, disperse themselves in the froth, and are scraped off the flotation tank. Then the froth is beaten out and the ore is free from most of the gangue which has, because wet by water, gone to the bottom of the flotation tank. More than 60,000,000 tons of sulphide ores are thus treated in the United States every *year and carried much more cheaply to* a higher concentration than was obtained by the old methods.

In the following ways, then, the subject of colloids touches the flotation process. The oil coat held by adsorption on the sulphides is so thin that the oil is really in colloidal state; in like manner, films of water of colloidal thinness wet or are adsorbed to the gangues. In a few cases colloidal kaolins and other clay substances are *present, which interfere with the flotation*, by adsorbing the oil and preventing its use by the sulphides. Here, too, the trouble increases if the oil is emulsified, for the finer the oil particles are, the more readily do the clay colloids adsorb them. Usually the ore is not ground fine enough so that its slime is at all colloidal. Electrolytes are sometimes used as an aid in flotation, for *they help to prevent emulsions, or coagu*late them if ormed.

PLASTICITY IN CLAYS.

This subject has been the theme for many interesting papers, and of some heated discussions, but the air seems to be clearing, and Ashley[17] writes that it is pretty generally believed by the students of ceramics that the control of plasticity in clays is a matter of the control of colloids. A number of other writers can also be quoted in support of this position. A French ceramic chemist, T. Schlösing, in 1888, P. Rohland in various papers from 1902-9, A. S. Cushman, quoted above, and F. W. Clarke in the Data of Geochemistry, all agree that the plasticity of clays can be very directly traced to their colloid content. Schlösing shows, according to Ashley, that the amount of colloidal material in the best clays is small, and rarely exceeds one and one-half per cent. As the percentage of material in the colloidal state decreases, so does the plasticity, and a clay with one-third of the amount mentioned is a lean *clay. Likewise, if the amount is greatly* increased above the one and one-half per cent., the clay becomes less plastic, and more sticky.

It is well known that the plasticity of clays is destroyed by ignition, and that the colloids are also made to change state by the same treatment. On the other hand, many thoroughly ignited clays absorb water quite as *well as unignited ones.* This makes it clear that the colloidal material is not the cause of the absorption of water, nor is the absorption of water vitally related to plasticity. Series of experiments have been made with lean clays to increase their plasticty, and it has been found that very poor clays can be made plastic enough to be worked successfully by adding small quantities of certain colloids; agar-agar 0.08 per cent. increases the plasticity of different *clays as much as 40 and in some cases* 60 per cent., and aluminium cream produced the same effects by adding in much larger quantities, *e.g.*, about 3 per cent.

As was shown on a previous page, colloidal material increases the tensile strength of shales, and it has been shown to do the same for clays. Other colloidal substances have also been used to increase the plasticity. Humus, *for example, an organic* colloid, produces beneficial results in lean clays. Clays in a cool, moist place improve in plasticity even within a few weeks. It is believed that the development of organic matter in the clay by the growth of bacteria, or even protozoa, is responsible for the improvement, for the protoplasm of these minute organisms is itself a colloid

If plasticity of clays should be found to be dependent upon the inorganic colloids in *them, it might be pertinent to ask if clays* and shales laid in the sea would be more plastic than those laid in fresh water, where the finest or colloidal material had difficulty in being precipitated.

Ries[18] has shown that the fineness of the material, the thinness of the plates in the shale, and the colloids, are each in themselves inefficient to fully explain plasticity. His theory suggests that plasticity may be due to cohesion and adhesion factors which depend on the constitution of the molecule,

[17] *Ashley, H. E., Bur. Stand., Tech. Paper*, 1911, XXIII.

[18] *Ries, H., Geol. Survey, W. Va.*, 1905, vol. III., pp. 46-54.

but not on the chemical composition. It might be said that he does not seem to be fully satisfied with his explanation, for he adds that "practical work to improve the plasticity of clays may follow lines already started, such as the addition of colloids, and weathering, which may mean the addition of colloidal material by bacterial growth."

One can never understand the raw materials and their relations to the finished products in cements, brick and terra-cotta, pottery, porcelain, enamels, and glass, until he has dipped rather seriously into the study of colloids from the geologic side. Weathering is a colloid-producing process, as well as a maker of most of the soils and the salts of the sea. Since macadam, brick, cement, and asphalt roads all start with materials whose vital properties are connected with the colloidal state of matter and the geologic processes that produce these materials, the road industry has real need of a colloid geologist.

Colloids in Soils.

Perhaps this topic will take us as far into questions of physiography as the last has into metallurgical and industrial processes, but in the last analysis, all three go straight back to geologic processes, and involve geologic problems. Soils result from the normal geologic decay of rocks, primarily of silicate rocks. In their decay, the elements K, Na, Ca, and Mg usually go into true solution in their secondary salts, while silica, aluminium, and iron go chiefly into colloidal solution and constitute the ultra-clay material of clays and shales.

In solutions, the colloidal material can be separated from the crystalline material by the use of the Sharple's centrifugal machine, capable of producing a force seventeen thousand times that of gravity, or by the use of the Pasteur-Chamberland filter. This separation can also be brought about by coagulation by the addition of salts, and by dialysis.

In soils the body is essentially sand and clay, the sand being made of fragments of many kinds of minerals, but mostly of quartz; and the clays mostly of hydrous aluminium silicates, with smaller quantities of aluminium and iron hydroxides. When the salts mentioned above come to the soils they are carried on through, providing the water has free circulation and drainage below; but if there is insufficient rainfall to equal evaporation, then these salts may be left in the soils and be continually carried to the surface by evaporation of the water. The colloidal material, however, will usually be adsorbed and will remain in the soil. Too much of the latter tends to clog a soil and prevent the free and necessary movement of air and water.

This last item becomes particularly troublesome in soils that must be irrigated, for irrigation waters differ from rain waters in carrying both true solution and colloidal solution materials, thus furnishing more material to clog the soil than rain waters. The difficulty is still further increased by the fact that most of the water on irrigated lands is removed by evaporation, so that everything of both kinds of solution is left in the soil. The colloids become a nuisance usually much before the salts do when ordinary stream water is used for irrigation. The colloids tend to cement the soil together some little distance below the surface, usually not beyond the reach of the plough, and produce there a "hard pan" layer. This interferes with the movement of the water, either up or down, and of course prevents the roots striking deeply. It can be broken up by deep cultivation, but the soil experts are now of the opinion that treatment with an electrolyte is really better. Aluminium sulphate has been successfully used in a number of cases. It acts much as the salts do in the sea, by coagulation of the colloidal material into little pellets, large enough so that the water and the air can get among them, and thus prevents their operation as cements.

In western United States, where most of our irrigation is carried on, there have been discovered in recent years great quantities of aluminium sulphate, and it is beleved that a large use of this salt will greatly extend the life of our irrigated soils.

The subject of colloids in geology is just ebginnng to attract the atteution of men who should be concerned with it. While the chemists have tackled their colloid problems with vigour and enthusiasm, the geologists have all but neglected the whole field. There should be many geologists turning their attention seriously to the solution of the great numbers of problems now before us, such as these suggested in this paper, and there should be many more geologists keeping up with the literature that discusses these colloid problems.

Department of Geology and Geography,
Oberlin College, Oberlin, Ohio.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY OF LONDON.

PROCEEDINGS AT THE MEETING HELD ON *DECEMBER 8, 1922, AT THE IMPERIAL* COLLEGE OF SCIENCE.

Alexander Russell, M.A., D.Sc., in the Chair.

1. A paper on "*The Relation between Molecular and Crystal Symmetry as shown by X-ray Crystal Analysis,*" was read by MR. G. SHEARER, M.A., B.Sc.

ABSTRACT.

The methods of X-ray analysis enable the number of molecules associated with the unit cell to be determined. With the help of this information an attempt is made to connect the symmetry properties of the crystal with this number and with the symmetry properties of the molecules from which the crystal is formed.

The symmetry number for each of the 32 crystal classes is given, and is shown to mean the minimum number of asymmetric molecules necessary in the unit cell to satisfy the symmetry conditions. The relative orientations and positions of these molecules in the cell are discussed.

It is suggested that this symmetry number is the actual number of molecules in the cell when the molecule is asymmetric; further that, if the molecule possesses symmetry, this symmetry appears also in the crystal, and the number of molecules in the unit cell is obtained by dividing the symmetry number of the crystal by the symmetry number of the molecule.

Evidence is produced in support of these hypotheses and examples are given of their application to inorganic and organic crystals.

DISCUSSION.

The President, before calling on Sir William Bragg, congratulated him in the name of the Society on the honour recently conferred upon him by the Paris Academy of Sciences.

Sir William Bragg, after acknowledging the congratulations tenrered to him, said that the paper before the meeting was an important one, throwing a new light on the possibilities of investigating crystal structure. The Author's intricate but lucid argument affords a great simplification of the problem. Three unitary structures have to be considered: (1) The chemical molecule, as it exists in solution; (2) the elementary crystal lattice or cell, consisting of groups of (3) crystal molecules, in which the atoms and electrons are not necessarily arranged in the same manner as in chemical molecules. The author's method enables one to determine the symmetry of these groups at once from the geometry of the crystal, with a very little help from X-rays. A considerable vista of research is thus opened up, which may serve to settle such questions as that of the static versus the dynamic model of the atom.

Dr. J. W. Evans thought that the methods employed by Mr. Shearer gave promise of proving of great assistance in working out the structure of crystals. There were, however, some considerations that must not be neglected:

(1) It is by no means certain that molecules always maintain their identity in the crystalline state.

(2) Even where they exist in the crystal, thtey may not retain the same form and symmetry as in a free state.

(3) Although in an ideal crystal all the cells are identical, and have identical orientation, this is by no means always actually true. We know that cells of different composition may be employed indiscriminately if they are approximately the same in form and volume, as in the case of the plagioclase felspars.

In the same way, if the outer forms of cells of the same substance approximate to a higher symmetry than the cell itself, these cells may, even when differently orientated, be employed in building up a crystal structure. The same may be true with cells that are enantiomorphically related. In these cases the whole structure may have a higher symmetry than the individual cells as the result of either (*a*) a symmetrical arrangement of the cells in the nature of molecular or ultramicroscopic twinning—twinning is usually an attempt to attain higher symmetry—thus forming lattice cells of greater size; or (*b*) indiscriminate occurrence of cells differing in orientation or in enantiomorphic character. In the former case it might be very difficult to recognise by means of X-ray analysis the primary cells. In the latter case it would, I should think, be impossible.

The explanation of the crystalline structure of potassium chloride is not convincing. The symmetry of the molecules shown is that of the quartz or tri-

gonal trapezohedral class which is represented by the symbol IIIUh (J. W. Evans, *Min. Mag.*, Vol. XV., pp. 398-400, 1910), with three digonal axes at right angles to a trigonal axis, and making angles of 120° with each other; whereas that of the crystal structure is stated to belong to the cuprite or pentagonal eikositetrahedral, CUh class, in which there are four trigonal axes corresponding to the diagonals of the cube and three digonal axes at right angles to one another and parallel to the edges of the cube. The cell contains four molecules, and the trigonal axes of these are supposed by the author to be at right angles to the diagonals of the cube, but it is not explained how the 4 x 3 digonal axes at right angles to the diagonals are transformed into three digonal axes at right angles to one another.

From the examination of the material prepared at the Imperial College and a comparison of the work of other observers, Miss Knaggs, of the Imperial and Birkbeck Colleges, has shown that the symmetry of the crystal structures of the simpler carbon compounds frequently bear close relation to that of the molecule. Substances of the type CX_4, where X is an element, are usually cubic. Those of the types CX_3Y are trigonal or hexagonal, unless X is hydrogen, when the symmetry is lower. Those of the form $C(CX_3)_4$ are as a rule cubic, and those with $C(CX_2Y)_4$ are tetragonal. In all cases the symmetry is apt to be that of a higher or different class than would have been expected, though one belonging to the same system. In the case of the $C(CX_2Y)_4$ compounds the symmetry of the molecule would be that of chalcopyrite or tetragonal scalenohedral, IVBk class, whereas that of the crystal usually belongs to the IVBc, or in one case IVBu class. It can be shown that symmetry of this character would be obtained by appropriate molecular twinning. Some of the compounds considered are dimorphic, crystals with less symmetry forming at a lower temperature.

The Speaker threw out the suggestion that crystal structure might possibly be due to the repulsion of the electrons of different atoms combined with an attraction of the atoms as a whole. If it be supposed that, contrary to the usual view, there are six outer electrons in chlorine having their mean position arranged like the points of an octahedron, and that in potassium there are eight electrons arranged like the points of a cube, it will be evident that a position of stability would be obtained when the points of each chlorine octahedron were opposite the centres of faces of the surrounding potassium cubes and the points of each potassium cube were opposite the centre of a face of a chlorine octahedron, and that the potassiums and chlorines would then be arranged alternately in a cubic lattice just as we know to be the case.

The author's reply will be communicated later.

2. A paper on a "*Modification of the Powder Method of Determining the Structure of Metal Crystals*," by E. A. Owen, M.A., D.Sc., and G. D. Preston, B.A., was read by Mr. Preston.

ABSTRACT.

Plates of aluminium, iron, copper, lead and magnesium have been examined by means of the Bragg X-ray spectrometer, employing radiation direct from a molybdenum anti-cathode. The maxima observed in the spectra are sufficiently intense to measure with accuracy, and the crystalline structure of the materials examined are readily determined. A few of the results obtained by the method are included in the paper as typical examples.

DISCUSSION.

Sir William Bragg congratulated the authors on their work, which indicated that the technique of crystal analysis is improving, and that its methods are coming into general use. A consideration to be borne in mind is that one of the crystal planes may become unduly accentuated by the polishing process. Further, in the case of aluminium and other metals, it is possible for individual crystals to be very large.

Dr. G. D. West, after dwelling on the advantages of focussing the X-ray beam by inclining the plane in which the crystals lie, inquired as to the width of the slits employed as the conditions varied, and as to the allowance to be made for variations in the output of the bulb.

Mr. Preston, in reply, stated that the authors had been careful to use crystals less than 1 mm. in size. The chamber slit was kept at 2 mm., and the bulb slit varied from 2 mm. to 4 mm. for different parts of the spectrum. The output of the bulb could be kept constant by regulating the filament current, but for moderate accuracy little regulation was required.

3. A paper on "*The Cathode Ray Oscillograph*," by A. B. Wood, D.Sc., was read by Capt. C. S. Wright.

ABSTRACT

The paper deals with a new form of cathode-ray oscillograph adapted for commercial production and laboratory use. The instrument described is of the low-voltage type, in which a hot cathode is employed as a source of the electron current. This low-voltage type of oscillograph is much more sensitive than the high-voltage cold-cathode type designed by M. Dufour. Various methods are described for focussing the cathode-ray stream, and a proposal has been made for an oscillograph with external (*i.e.*, outside the vacuum) photographic film. Experiments have been made to determine the most suitable photographic film or plate. Ordinary gelatine-coated roll films or plates are unsuitable, owing to the marked absorption of the cathode-rays by the gelatine. The best results have been obtained with Schumann plates containing a proportion of calcium tungstate. This material phosphoresces with a light rich in ultra-violet, and consequently the secondary luminous effect on the Schumann plate is very great.

Mechanical, electrostatic and electromagnetic methods are described for generating a time-axis on the records. For certain purposes this time axis is sinusoidal, whilst for others it is linear. Numerous records of high-frequency A.C. wave forms and of impulsive electrical phenomena have been obtained, and a few of these are reproduced in the paper. Brief reference is made in conclusion to the applications of the oscillograph to research and electrical engineering problems, where other well-known forms of oscillograph (Duddell, Einthoven, &c., types) cannot be employed on account of the inertia of the moving element.

DISCUSSION.

Mr. Mines inquired whether any measurement had been made of the potential gradient in the tube with a view to determining the distribution of potential along the path of the rays. Was anything known of the current density of the rays, and was there (as in the arc lamp) a limiting value to such current density, involving a maximum intensity for the spot of light beyond which it would be impossible to go? And had the author tried the focussing effect of charging the cylindrical shield to a potential of, say, 100 volts?

Mr. R. A. Watson Watt (partly communicated): I would join in congratulating Dr. Wood on his very lucid account of a most important and valuable instrument of research. Perhaps the most outstanding feature of his work is the way in which the oscillograph has been converted into a robust engineering structure, which the "glass shy" engineer can approach with more confidence than he feels towards the older forms of blown glass tube, and into an instrument with a much higher expectation of life than these older forms possessed.

In considering cathode ray oscillographs in general, one should not lose sight of the fact that there is a wide field of application for sensitive tubes in which it is not necessary to resort to photography with its attendant difficulties and complications. Single axis working, in which the tube is valuable as a direct reading high-frequency voltmeter, is in itself sufficient justification for such tubes. But Dufour has shown that in wave form work one can obtain visual images of radio frequency wave forms from his high-voltage tubes, while recently, by the courtesy of the International Western Electric Co., I have been able to satisfy myself that a reliable visual image of a transient deflection of 10^{-4} sec. duration can be obtained with the 300-volt beam of their tube. The fluorescent spot had a translational speed of about 5×10^{-4} cm. per sec. in this experiment. This, whether due to persistence of vision or to persistence of fluorescence, is much more satisfactory than one had the right, *a priori*, to expect.

On minor matters of detail it might be desirable in a paper which will take an important place in the chronology of cathode ray oscillographs that the author should make it clear that he does not assign priority for the introduction of the hot cathode, of the A.C. time base, and of the D.C. time base, to the workers referred to in this paper. The author's own familiarity with the history of the subject might lead to the appearance of neglecting the priority of Wehnelt (1906) as to the hot cathode, of Fleming (1913) as to the A.C. time base, and of Dufour (1914) as to the D.C. time base, which he superposed on the A.C. base, so that the final image is based on the plane projection of a cylindrical helix.

I should be grateful if Dr. Wood could say whether any data are available as to a tube working on the 100 volts, which he mentions as a lower limit. A tube of this extreme sensitivity would be most valuable,

but I know of no references to a stably operating tube with an accelerating voltage below 300 volts.

Finally, I should like to ask the author whether he has any experience of Van der Bijl's "positive ion" method of focussing, as used in the Western Electric tube. It appears to be a method of great value, particularly in view of the fact that the commonly used electro-magnetic "paralleling" method reduces the sensitivity of the tube. My experience of low-voltage tubes leads me to conclude that at the present moment the limitation of sensitivity for visual observation lies, not in the mechanism of beam production or concentration, but in the fluorescent materials used for the screen, and that progress in that direction can still be made.

Mr. R. S. Whipple said that the beautiful instrument described would meet a real demand, as oscillographs using a cold cathode are cumbersome and costly, while the one under discussion should be within the means of most laboratories. The method of phosphorescent sensitisation opens up great possibilities. The paper is written in such a way as to be unusually readable.

The reply to the discussion will be communicated later.

4. *A DEMONSTRATION of a Low Voltage Cathode Ray Oscillograph* was given by MR. R. WEBB, International Western Electric Company.

This instrument, which is designed to work at 300 volts, is intended for manufacture on a commercial basis. The cathode consists of a hot platinum filament coated wit hcertain oxides, and formed into a circle coaxial with the path of the rays. It is protected from bombardment by positive arys, which would disintegrate it, by a screen in which is cut a circular hole slightly less in diameter than the filament. It has a life of about 200 hours. The anode is a platinum tube through which the rays pass. The deflecting fields are electrostatis, and are provided by two pairs of plates at right angles. The bulb is in the form of a conical flask, the cathode being at the narrow end so that the rays impinge on the flat bottom which is coated inside with fluorescent matter. The luminous trace of the rays can be seen from outside through the bottom of the flask. The apparatus was connected up* to show the characteristic of an oscillation-generating valve, so that the potential difference between one pair of plates was proportional to the grid potential, and that between the other pair to the plate current. The resulting trace consisted of a single curved line terminating in a loop of peculiar form at one end.

* *E. V. Appleton, Phil. Mag., August,* 1921.

The Annual Exhibition of Apparatus arranged by the Optical Society and the Physical Society of London, was held on January 3rd and 4th, 1923.

The following lectures were given:—

"*Reproduction of Colour by Photographic Processes,*" by MR. W. GAMBLE (on January 3 at 4 p.m., and January 4 at 8 p.m.).

"*Recent Photo-Elastic Researches on Engineering Problems,*" by PROF. E. G. COKER, F.R.S. (on January 3 at 8 p.m., and January 4 at 4 p.m.).

PLATINUM DEPOSITS.*

By James M. Hill.

The Salt Chuck palladium-copper mine in Alaska was not operated in 1921, though one shipment of concentrates produced in 1920 was sent to the United States. The output of placer platinum came mainly from Dime Creek, on Seward Peninsula.

California dredges produced practically all the crude platinum reported for 1921, a total of 821 ounces. Of this quantity 486 ounces came from the streams of the mother lode region, and 335 ounces from Trinity County. A large part of the Trinity County crude platinum is osmiridium, recovered from Beegum and Hayfork creeks and by the dredges on Trinity River.

A large part of the 91 ounces of crude platinum reported by Oregon miners was produced at the beach mines in Coos and Curry counties, though some crude platinum was saved from the mines near Kerby and Waldo, in Josephine County, and near Sumpter, in Baker County.

The Electrolytic (formerly Rambler) mine, near Holmes, Albany County, Wyo., was under development during the year, and a car of ore was shipped principally for its copper value.

A number of platinum booms were launched in 1921, notably one based on reports of rich platinum ore 11 miles from Winnemucca, Nev., and another on a reported deposit of platinum near Batesville, Ark.

CANADA.

The largest production of platinum metals in Canada comes from the refiners of the Sudbury nickel-copper ores. The International Nickel Co. closed its mines and refinery September 1, 1921. The Mond Co. is the only one now operating.

COLOMBIA.

Two dredges of the South American Gold and Platinum Co. were in operation in Colombia throughout the year, and a third dredge was expected to be in operation early in 1922. The boat of the British Platinum and Gold Corporation is reported to have made satisfactory recovery,[1] the output from December 21, 1920, to May 21, 1921, being 966 ounces. A dredge has been ordered by the newly organised Colombia Proprietary Gold Mines (Ltd.), a British concern, to operate on Llantin River, 70 miles south of Buenaventura. It is stated on good authority that the native production of platinum decreased considerably during 1921, owing to the lower price paid for the metal by local buyers, which naturally was reduced in conformity with the New York market. It is believed that the production may decline somewhat from that maintained during the war period for a few years, until sufficient dredges are installed to handle adequately the large reserves of gravel.

PAPUA.

The first recorded shipment of osmiridium from Papua was made in 1921 and amounted to 88 ounces. Australians evidently believe that the east end of New Guinea may yet prove a mining field for this valuable iridium-osmium alloy.

RUSSIA.

Very little real news concerning the situation in the Russian platinum fields has heen forthcoming. Apparently a little hand mining is going on. Late in 1921 it was reported that a State-controlled platinum trust had heen organised by the Soviet Government, and in May, 1922, it was rtported that Louis Duparc[2] is going to Russia to reorganise the platinum-mining industry at the invitation of the Soviet Government.

It is reported[3] that the production of platinum during the first half of 1921 was about 2,700 ounces.

TASMANIA.

The production of osmiridium in Tasmania in 1921 was 1,750 ounces, as compared with 2,009 ounces in 1920, 1,670 ounces in 1919, and 1,607 ounces in 1918. This is rather surprising in view of the fact that the prices paid for the alloy have been continually lowered until it was reported that many miners had abandoned operations. An excellent description of the various fields in Tasmania in which osmiridium is mined is that by Reid,[4] published in 1921.

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* *By James M. Hill. Mineral Resources of the United States, 1921— Part I. Government Printing Office, Washington*, 1922.

[1] *Min. Jour. (London)*, 1921, vol. XXV., p. 50.

[2] *Eng. and Min. Jour.-Press*, 1922, vol. CXIII., No. 18, p. 786.

[3] *Note by Dept. Commerce of a translation from Economic Life.*

[4] *Reid, M. A., Osmiridium in Tasmania: Tasmania Geol. Survey Bull* 32, 1921.

A PRELIMINARY STUDY OF ZIRKITE ORE.

BY J. G. THOMPSON.

(*From the Journal of Physical Chemistry, New York, December*, 1922.)

This investigation consists of a study of zirkite ore (crude zirconium oxide), with attempts to improve the refractory properties by the elimination of certain of the impurities present in the raw material.

Pure zirconium oxide, if available in sufficient quantity, would aid materially in solving the problems of the users of high-temperature refractories, particularly those problems connected with the extreme temperatures encountered in the use of the electric furnace. As a refractory for high temperatures zirconium oxide is far superior to any of the materials commonly employed for this purpose, and in some respects it approaches the ideal refractory. It possess[1] a melting point higher than that

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[1] *Meyer: Met. Chem. Eng.*, 1914, XII., 791; 1915, XIII., 263; *Hedvall: Zeit. anorg. Chem.*, 1915, XCIII., 313; *Bradford: Chem. Trade Jour.*, 1918, LXII., 284; *Arnold: Jour. Soc. Chem. Ind.*, 1918, XXXVII., 724; *Granger: Chem. News*, 1919, CXVIII., 115, 121.

of any other known metallic oxide; it is non-volatile below its melting-point; it is neutral in character and inert to the action *of practically all of the common reagents*: it possesses low coefficients of thermal and electrical conductivity. These properties ensure the successful use of pure zirconium oxide as a refractory, even for the most extreme service conditions, at any time when it becomes available in quantity.

(*To be Continued.*)

GENERAL NOTES.

INTERVIEWS WITH HIS MAJESTY'S COMMERCIAL SECRETARY IN ARGENTINA.

Mr. H. O. Chalkley, His Majesty's Commercial Secretary at Buenos Aires, will be in attendance at the Department of Overseas Trade for a few days, from January 18, 1923, and will be pleased to interview manufacturers and merchants interested in trade with Argentina.

Applications for interviews should be made as soon as possible, and in any case not *later than January* 17, to the Comptroller-General, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1, the reference, T.G.4380, being quoted in all cases.

Department of Overseas Trade.

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING OF INDUSTRIES ACT—PART I.
ARBITRATIONS UNDER SECTION 1 (5).
Oxalic Acid.

Judgment has been given by the Referee in the matter of a complaint under the above sub-section, that Oxalic Acid has been improperly included in the lists of articles chargeable with duty under Part I. of the Act. The Referee has awarded that the complaint fails, and the lists therefore remain unaltered.

Board of Trade,
20th December, 1922.

NOTICES OF BOOKS.

Smith's Intermediate Chemistry, revised and rewritten by JAMES KENDALL and EDWIN E. SLOSSON. Pp. XV. + 566 + 16 plates. For Great Britain: G. Bell & Sons, Ltd., Portugal St., Kingsway, W.C. 1922. Price 8s. 6d.

Alexander Smith's *Chemistry* bears the stamp of much originality, and was written by one possessed of great teaching qualities. Although in some respects the book was not perfect, it undoubtedly was a very good textbook.

The present edition has been extensively revised and brought well up to date by Profs. Kendall and Slosson. It is eminently suitable for students in colleges and technical institutes, and also for those who do *not regard chemistry as their principal subject.*

Besides the usual textbook features there is much interesting and apposite information upon matters usually ignored in such works as this, which are intended to maintain and retain the students' live interest in the subject.

Extensive additions to the earlier edition have been made to incorporate the latest information concerning Atomic Energy and Structure The subject matter is frequently treated from the viewpoint of physical chemistry. The importance of this in the study of general chemistry is justly emphasised.

The Introduction, "*Why Study Chemistry?*" makes very refreshing reading. It is pointed out that chemistry began as a secret science. The early chemists concealed their knowledge (and their ignorance) under mystic symbols. The modern chemist, on the other hand, is more anxious to explain what he knows than people are to listen to him.

Chemistry is well fitted to give training in the scientific method, since it is *experimental*. Properly taught — or properly learned — it inculcates self-reliance and independence of thought. Further, the qualified chemist has two strings to his bow. If he does not like teaching, he may enter the industrial field. He may be engaged in routine analysis of raw and finished products, or be in control of processes, or engaged in research to utilise waste products, or to invent new compounds or new uses.

In some fields of Chemistry, women have almost an equal chance with men.

Chemistry should have an interest and utility for everyone. J.G.F.D.

The Mysteries of Hypnosis (*Les Mys-*

tères de l'Hypnose), by GEORGES DE DUBOR, translated by G. M. HORT. Pp. IX. + 235. London: William Rider & Son, Ltd., 8, Paternoster Row, E.C.4. 1922. Price 5s. net.

It is regrettable that psychical phenomena have been exploited, in the past, by charlatans, and consequently their study has been discredited. Happily, this stage is rapidly passing, particularly in view of the number of eminent scientists who have witnessed and investigated these phenomena, and who vouch for their authenticity.

This interesting scientific and authoritative treatise upon Hypnosis can be safely recommended to those desirous of ascertaining the facts and phenomena concerning this subject.

The author has been careful to select fully authenticated cases, and has included those instances which are most striking and illustrate his contentions. J.G.F.D.

BOOKS RECEIVED.

Smith's Intermediate Chemistry, revised and rewritten by JAMES KENDALL and EDWIN E. SLOSSON. Pp. XV. + 566. 1922. New York: The Century Co. Sold in Great Britain by Messrs. G. Bell & Sons, Ltd., Portugal Street, Kingsway, W.C.2. 8s. 6d. net.

The Theory of Emulsions and Emulsification, by WILLIAM CLAYTON, D.Sc. (LIVERPOOL), F.I.C., Foreword by PROFESSOR F. G. DONNAN, C.B.E., M.A., &c. Pp. VI. + 160. 1923. Messrs. J. & A. Churchill, 7, Great Marlborough Street, W.1. 9s. 6d. net.

Bleaching Powder and its Action in Bleaching, Original Memoirs by R. L. TAYLOR, F.I.C. Pp. 78. 1922. Messrs. John Heywood, Ltd., 121, Deansgate, Manchester. 4s. 6d.

New Patents.

THIS list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

33109—Harris, H.—Separation of arsenic and tin in presence or absence of antimony. Dec. 4.

33075—Hirchberg, L. M.—Extraction of sulphur and sulphur compounds. Dec. 4.

33605—Williams, J. G.—Manufacture of low relative density oxide and carbonates of magnesium. Dec. 8.

Specifications Published this Week.

163047—Nitrogen Corporation.—Process of preparing mixtures of nitrogen and hydrogen such as are suitable for the production of ammonia.

167156—Man, W.—Manufacture of concentrated hydrogen peroxide solution.

188772—Wolverkamp, M. E.—Salts of oxidised protalbinic and lysalbinic acids.

188811—Deutsche Gold & Silber-Scheideanstalt vorm Roesseler an Schaidhauf, Dr. A.—Process of bleaching textile fibres.

188815—General Electric Co., Ltd.—Apparatus for transforming the crystal structure of wires, filaments, and the like.

177972—L'Air Liquide Soc. Anon. Pour L'Etude et l'Exploitation des Procedes, G., Claude.—Synthesis of ammonia.

188933—British Dyestuffs Corporation, Ltd. and Wyler, M.—Manufacture of phenyl glycine compounds.

172944—Aktieselskabet Labrador.—Precipitation of iron in mineral acid alumina solutions.

189160—Gitsham, J., and Evershed, H. R.—Process for the manufacture of sulphate of lead.

189193—Wake, J. F.—Rotary apparatus for drying, calcining, or roasting ores, low temperature distillation of fuel, and apparatus for similar purposes.

181375—Aktieselskabet de Norske Saltverker.—Process of producing anhydrous magnesium chloride.

185403—Farbwerke vorm. Meister Lucius & Bruning.—Manufacture of thiohydrins.

Abstract Published this Week.

Manures: Ammonium Salts: Ammonia.—Patent No. 187251.—Some improvements in processes for obtaining artificial manures have been devised by Mr. E. L. Pease, of Hurworth Moor, Darlington, County Durham.

Manures containing an ammonium compound or compounds and a secondary fertilising agent or agents, such as a salt of potassium or a phosphate, are obtained by reaction between gases containing ammonia and the semi-dry product obtained by treating with acid a naturally-occurring material that contains the secondary fertilising agent or agents, but which is free, or almost free, from lime, and is not generally regarded as a manure in itself. Thus clay containing a compound of potassium may be treated with sulphuric acid, if desired, after drying and pulverising in sufficient amount to constitute a semi-dry mass, which is brought into contact with gases containing ammonia. The product contains the oxides of iron and aluminium, and ammonium sulphate, together with a soluble compound of potassium, the content of which may be increased by direct addition of potassium salts. Other examples of naturally-occurring materials, suitable for use in the process, are alunite and shales containing iron aluminium, sulphur and potash, with or without phosphorus. Alunite may be calcined and used without any addition of acid. Instead of sulphuric acid there may be used sulphur dioxide or trioxide, hydrochloric or phosphoric acid, spent pickling-liquor, or acid salts, or mixtures of any of these. Where phosphoric acid is used, gases containing ammonia may be treated in a heated condition; if, however, the absorption is allowed to proceed for a long time at atmospheric temperature, material containing tri-ammonium phosphate is obtained. The products may be lixiviated to remove the soluble salts, or they may be heated to about 400° C., when about 50 per cent. of the ammonia present is evolved, leaving a residue still suitable for use as a fertiliser or for re-use in the process. Alternatively the ammonia may be expelled by means of lime.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3274.

THE BRITISH EMPIRE EXHIBITION (1924).

THE CHEMICALS SECTION.

Arrangements have now been completed for organising on a very large scale the Chemicals Section of the British Empire Exhibition. The organisation of the Section has been entrusted to the Association of British Chemical Manufacturers, whose Committee will be reinforced by representatives of the Society of Chemical Industries and kindred bodies connected with the Chemical Industry and Science. The work of letting space is now proceeding, 25,000 sq. ft. having been allotted to the Chemical Section.

Mr. W. J. Woolcock, of 116, Piccadilly, is acting as Secretary, and there is every indication that the exhibit will be one fully worthy of the great Chemical Industry. In fact, it may be said that this section stands next to the engineering, electrical, and transport sections of the Exhibition in the satisfactory demand for space. A large number of the big manufacturing firms of the kingdom have already applied. It is probable that a portion of the section will be devoted to perfumery. Suggestions have also been received from firms desiring to show the whole process of toilet soap making by modern machinery, with shaving and toilet soaps of all descriptions, dentifrice, and other toilet preparations.

THE ESTIMATION OF MAGNESIUM IN ALUMINIUM ALLOYS.

By W. H. WITHEY, B.A. (CANTAB.), OF THE NATIONAL PHYSICAL LABORATORY.

The increasing use of magnesium in aluminium alloys containing several metals has complicated the analysis of such alloys, and any method by which it can be shortened without loss of accuracy is very much to be desired.

In a paper read before the Institute of Metals in 1916, the author published details of a method in which use was made of the fact that tartaric acid prevents the precipitation of iron and aluminium by ammonia, but at the same time does not prevent the estimation of maguesium as phosphate even in the presence of a large quantity of aluminium.

In the process as originally devised, metals such as zinc, copper, nickel, iron, and any others which could be separated by sulphuretted hydrogen, were removed prior to determining the magnesium as phosphate. This necessarily lengthened the process, since it prevented the estimation of the magnesium in a separate portion.

As a result of experiments it has now been shown that it is not necessary to remove metals such as zinc, copper, nickel and iron (if present in only small amounts), and that the accuracy in the subsequent determination of the magnesium is quite as high as when the metals are absent. The method has been tested, as regards accuracy, by adding a definite amount of magnesium to solutions of aluminium containing copper, zinc, and nickel, in proportions which are not likely to be exceeded in practice, and then estimating the amount of magnesium present. The figures thus obtained agree very closely indeed with those found in the same amount of the pure magnesium solution. The details as given below for the test experiments are applicable to the analysis of aluminium alloys not containing more than 1 per cent. of magnesium, the amount of alloy used for the analysis being 2 gms. To obtain successful results the conditions must be careully observed, particular care being taken to see that the solution is *very distinctly* alkaline before the addition of the sodium phosphate, otherwise there is a risk of contaminating the magnesia precipitate with some of the heavy metallic phosphate. If, on addition of the sodium phosphate, a precipitate is produced immediately, more ammonia should be added, when it will be found that the precipitate redissolves, and that only after some time does the magnesia commence to come down.

For the purpose of the tests, a very impure aluminium (Si 0.36, Fe 1.50, Cu 0.65) was chosen, and several portions of 2 gms. dissolved in a mixture of 30 cc. hydrochloric acid, 10 cc. nitric acid. This was followed by evaporation to dryness after the addition of 15 cc. sulphuric acid. The dried mass was dissolved in water, and the silica removed by filtration. To each of these solutions was added 15 gms. of tartaric acid dissolved in 75 cc. water, 5 gms. ammonium chloride, and 5 cc. of a stand-

ard solution of magnesium sulphate. The metal whose action was to be investigated *was added in the form of a standard solution*, and one metal only was used for each *separate test*.

The solutions as thus prepared were *next treated with strong ammonia* (s.g. 0.880) until they were *very distinctly* alkaline, 40 cc. was found to be sufficient for the purpose. Twenty-five cubic centimetres of a saturated solution of sodium phosphate were then added and the liquids vigorously stirred, and more ammonia added until it formed at least one-third of the total volume, which should be about 400 cc. After allowing to stand overnight, the solutions were filtered, washed with dilute ammonia, and then dissolved in hydrochloric acid, and precipitated again in the presence of 1 cc. of a saturated solution of sodium phosphate, as in the case of pure magnesium in solutions.

When the precipitates had settled for several hours, they were again filtered, washed as before, and ignited. In the case of alloys containing manganese it will *usually be found that the magnesium precipitate* contains a portion of the manganese. *The ignited precipitate should* therefore, be dissolved in nitric acid s.g. 1.2, *cooled, treated with sodium bismuth*ate, filtered and titrated with ferrous ammonium sulphate, and any manganese thus found calculated as $Mn_2P_2O_7$ and deducted from the weight of the impure phosphate.

Any traces of calcium present in the alloy would also probably be precipitated, but as a rule calcium is only likely to be introduced by means of the magnesium used in making the alloys, the actual amount of calcium is likely to be very small indeed, and for any but the most accurate analyses could be ignored. In certain cases where calcium is added intentionally, although in small amounts, a modification of the process may be necessary.

EXPERIMENTAL RESULTS°

Weights of metals present.

Al	Fe	Cu	Zn	Ni	$Mg_2P_2O_7$ found	Mg Calculated
nil	nil	nil	nil	nil	0.0568	0.0124
2.0000	0.0300		nil	nil	0.0562	0.0125
2.0000	0.0300	0.1000	nil	nil	0.0566	0.0124
2.0000	0.0300	0.5000	nil	nil	0.0570	0.0125
2.0000	0.0300		0.2278	nil	0.0580	0.0127
2.0000	0.0300	nil	0.4556	nil	0.0604	0.0129
2.0000	0.0300	nil	nil	0.2000*	0.0562+	0.0123
2.0000	0.0300	nil	nil	0.4000*	0.0552+	0.0121

\+ In these cases pure metallic nickel was used, dissolved in aqua-regia.

* In the first experiments made with nickel a sample of nickel ammonium sulphate was used, which proved to be contaminated with magnesium. 1 gm. of the salt was added to one solution and 2 gms. to the other. The weights of precipitates obtained were 0.0714, 0.0838; on treating some of the nickel salt alone in the presence of tartaric acid and phosphate 2 gms. gave 0.302, which amount of $Mg_2P_2O_7$ was also obtained after separating all other metals previous to precipitating the phosphate. Making the corrections for the magnesium in the nickel salt, the amounts corrected shoull have been 0.0563 and 0.0536, corresponding with 0.0123 and 0.0118 Mg.

The method has also been tried on two alloys of a fairly complex type, which on analysis by decomposing with caustic soda and subsequent determination of the metals seriatim, gave

	1	2
Si	0.22	0.22
Cu	2.29	3.91
Mn	0.58	nil
Mg	0.61	1.56
Zn	19.10	nil
Ni ..	nil	1.93

After removal of the silica and applying the tartaric method as above, the magnesium found was respectively 0.59 per cent. and 1.54 per cent., as against 0.61 and 1.56.

The precipitates obtained in the first series of experiments were also examined for possible contamination, by dissolving them in dilute hydrochloric acid followed by careful neutralisation, addition of sodium acetate and dilute acetic acid. The slight precipitate was redissolved, and reprecipitated, and on ignition was proved to

be a minute quantity of ferric phosphate which was without significance in the result. It should also be pointed out that with the exception of the filtrate from the magnesium phosphate solution obtained from the copper solution, only a faint darkening, but no precipitate, with sulphuretted hydrogen could be obtained. The method may, therefore, be regarded as reliable, and is more expeditious than the older methods, as it enables the magnesium to be estimated on a separate portion of the alloy.

LEGAL INTELLIGENCE.

RICHMOND POLICE COURT.

ARSENIC IN COCOA.*

Summons Under Sale of Foods and Drugs Act, 1875.

At the instance of the Surrey County Council, on December 18, 1922, the Home and Colonial Stores, Ltd., were summoned fo r" selling at their George Street shop, Richmond, to the prejudice of Robert Alfred Houghton (county inspector), the purchaser, cocoa which was not of the nature, substance, and quality of the article demanded by such purchaser, but was adulterated with arsenic (arsenious oxide) to the extent of one-fortieth of a grain per pound of cocoa, contrary to Section 6 of the Sale of Foods and Drugs Act, 1875." Messrs. Rowntree and Co., Ltd., Cocoa Works, Haxby Road, York, were summoned for aiding and abetting in the commission of the alleged offence by the Home and Colonial Stores, Ltd.

The Mayor (Alderman P. E. Metzner) presided over the Bench. Mr. R. O. B. Lane (instructed by the Surrey County Council) prosecuted; Mrs. Travers Humphreys appeared for Messrs. Rowntree; and Mr. W. Ricketts appeared for the Home and Colonial Stores, Ltd.

Both defendants put in a formal plea of "Guilty."

Mr. Lane, for the prosecution, said the summonses were taken out by Mr. Houghton, an inspector of the Surrey County Council. On October 2 Mr. Emery, an assistant to Mr. Houghton, went to the Home and Colonial Stores, Richmond, and asked for a quarter of a pound of cocoa. He was served with a packet from under the counter, for which he paid 4½d. It was marked, "Home and Colonial pure cocoa essence, highest-grade quality, guaranteed absolutely pure cocoa." He was informed that the cocoa in question was not the actual manufacture of the Home and Colonial Stores, but a blend of seven different cocoas, one of which was manufactured by Messrs. Rowntree. Samples of the seven different cocoas were given to Mr. Emery, and when Messrs. Rowntree's sample was analysed, it was found to contain arsenic to the extent of one-tenth of a grain per pound. He wanted to say at once, and acting on his instructions, that he did not suggest that the Home and Colonial Stores were really to be blamed in the matter. There had been a breach of the law, but he did not think it could be said that there was any moral culpability attaching to them; but the law had to be carried out.

Mr. Edward Hinks, analyst to the Surrey County Council, said that he analysed a sample of cocoa in which he discovered arsenic to the extent of one-fortieth of a grain per pound. The quantity was excessive. On November 14 he received further samples of cocoa, and with regard to one marked "Rowntree" he found it to contain arsenic to the extent of one-tenth of a rgain to a pound of cocoa. The other samples he found to be genuine. In reply to Mr. Travers Humphreys, who asked him if he suggested that anyone was in the least likely to be injured in health hy the use of the cocoa containing one-tenth of a grain per pound, witness said he thought it was on the line where it might be harmful. He had not heard of anyone heing harmed hy it.

Mr. Travers Humphreys said Messrs. Rowntree took absolute responsibility for the position in which the Home and Colonial Stores had been placed. They hought from Messrs. Rowntree what they believed to be pure cocoa. Messrs. Rowntree were most anxious that two matters should be put clearly before the Bench. They desired first to put before the public through the Bench that in the opinion of the most competent scientific men there was not the smallest cause for anxiety as to illness or danger to the public from drinking the cocoa which was the subject of the prosecution. The other matter was that this was an accident which might have happened to any manufacturer of any article of food, in spite of the greatest possible care being taken to prevent impurities being present. In July last there was brought

to the notice of Messrs. Rowntree by some chemist that some of the loose cocoa supplied contained some faint traces of arsenic. The news came like a thunderbolt to the firm. Their chemists were put on double shifts, working day and night. Everything in the place was analysed, and for some time there was not the faintest notion where the arsenic could have come from. It was found that the impurity was in the alkali carbonate of potash, which had been used by Messrs. Rowntree for years. It was used in small quantities to make the cocoa soluble and more digestible. They got it from the best people in the trade. They found it contained a substantial quantity of arsenic, and they wrote to the manufacturers about it, but so far had not received any explanation. There was one thing they could do, and they did it instantly—they sacrificed the whole of the cocoa, 350 tons, representing many thousands of pounds, sacrificed it absolutely in order that nothing more might go out of their works. They then instituted a new test, and they were able to say with absolute certainty that as from August 1 every ounce of cocoa from their works was made from ingredients absolutely free from this impurity. There was on the market somewhere the amount of cocoa they had sent out containing this impure carbonate of potash. They first ascertained if it could do any harm. The view of the chemists was that the amount of arsenic present could not possibly injure anyone in health who consumed it. They considered whether it was possible to get back the cocoa they had sent out to the trade, but decided it was absolutely useless to try to get it back, because they had 65,000 customers, many of them wholesalers. The period during which the impure cocoa was sent out was only two months in all. Messrs. Rowntree came to the conclusion honestly that it was in the interests of the public not to create a quite unjustifiable scare in connection with such a valuable article of food as cocoa. He wished to emphasise that chocolates did not come into the matter in the least. Chocolates were made from cocoa which contained no addition of the carbonate of potash.

Mr. Arnold Rowntree said his firm had never spared any expense in regard to analysing articles of food. With regard to the incident, witness said the whole of the stock was sacrificed, amounting to about 300 tons, varying in value from £100 to £520 a ton.

Mr. Ricketts, on behalf of the Home and Colonial Stores, said they purchased the cocoa with a warranty from Messrs. Rowntree. Directly they heard that the cocoa contained impurity they withdrew sixty-five tons from their shops and twenty tons from their warehouses, involving them in a loss of £12,000.

A fine of 40s. was imposed against the Home and Colonial Stores, and £20 against Messrs. Rowntree, with 50 guineas costs.

* *From the "Pharmaceutical Journal and Pharmacist," December 23rd, 1922.*

THE TEMPERATURE COEFFICIENT OF THE REFRACTIVE INDEX OF AMERICAN TURPENTINE.

By Gartha Thompson (B.Sc., F.I.C.).

It is a remarkable fact that while it is generally recognised that it is impossible to compare refractive indices unless these refer to the same temperature, few attempts have been made to measure and record the variation of the refractive index with temperature. This is specially true of commercial liquids. Hence, there have been demands by analysts that all workers should adhere to a standard temperature when measuring refractive indices. The better way, however, is to ascertain both the refractive index and its temperature coefficient (*i.e.*, the decrease in refractive index per degree Centigrade), for then a small calculation is all that is necessary to reduce refractive indices to any desired temperature. The advantage of being able to calculate the refractive index for any temperature when its value is known at one temperature is obvious.

It is a fortunate fact, from this standpoint, that while liquids of analogous chemical constitution vary in their refractive indices, the temperature coefficients of these refractive indices remain fairly constant; and it is an equally fortunate fact, from another standpoint (viz., that of differentiating between substances of dissimilar chemical constitution), that while the refractive indices are often the same at one temperature, yet the temperature coefficients of the refractive indices vary widely. In fact, where dissimilar liquids are concerned, it is frequently found that there are far wider differences in the temperature coefficients of the refractive indices than in those constants themselves.

As is the case with many other liquids, the temperature coefficient of the refractive index of turpentine appears to have been neglected The only information which could be found on this subject is given in Kanthack's "Refractive Indices of Essential Oils" (Adam Hilger, Ltd.). Here the temperature coefficient of the refractive index of American turpentine is given as 0.00037, and it may be remarked that this figure is so low as to be quite outside the usual range of essential oils. It was therefore decided to carry out a series of tests, using the best commercial varieties of American turpentine.

The samples of turpentine numbered 1, 3, and 4 were described as "Genuine Commercially refined Spirits of American Turpentine"; sample 2 was described as best American Turpentine."

A Pulfrich refractometer constructed and recently calibrated by Messrs. Adam Hilger, Ltd., was used for the work, and temperature control was maintained by allowing a stream of water at the desired temperature to flow through the jackets enclosing the prism and cell and through the heater which was inserted in the turpentine in the cell. A sodium flame was used as illuminant throughout the experiments.

From the third columns in the tables it will be seen that there is little, if any, tendency for the temperature coefficient to alter with temperature.

All four samples of turpentine were examined chemically; for the figures in table 4 (with the exception of those for the second sample) I am indebted to the Routine Section of the Laboratories.

In conclusion, I desire to express my thanks to the Directors and Chief Chemist (Mr. W. B. Parker, F.I.C.), of the British Thomson-Houston Company, Ltd., for permission to use the research laboratories for this work.

TABLE 1. SAMPLE 1.

Temperature	Refractive Index.	Temperature Coefficient.
14.2° C.	1.474428	0.0004672
20.5	1.471486	0.0004663
32.1	1.466076	0.0004723
39.2	1.462722	0.0004633
48.0	1.458644	0.0004732
57.4	1.454197	Mean 0.0004684

TABLE 2. SAMPLE 2.

Temperature	Refractive Index.	Temperature Coefficient.
20.0° C.	1.469902	0.0004675
30.0	1.465227	0.0004710
45.0	1.458163	0.0004705
60.0	1.451110	Mean 0.0004696

TABLE 3. SAMPLE 3.

Temperature	Refractive Index.	Temperature Coefficient.
15.5° C.	1.472804	0.0004677
30.0	1.466022	0.0004735
50.0	1.456552	Mean 0.0004706

TABLE 4. SAMPLE 4.

Temperature	Refractive Index.	Temperature Coefficient.
15.5° C.	1.472853	0.0004711
30.0	1.466022	0.0004685
50.0	1.456652	Mean 0.0004698

TABLE 5.

Sample No.	Specific Gravity 15.5° C	Iodine Value,* 24 hours Hüpl	Distillation. 1st drop	Below 155° C	155° C to 165° C	Below 175° C	Below 185° C	Above 185° C
1	0.8679	423.1	152° C	0.05%	95.0%	96.5%	97.0%	3.0%
2	0.8724	407.3	153° C	2.05%	90.0%	93.0%	96.0%	4.0%
3	0.8705	399.2	155° C	—	93.0%	95.5%	96.0%	4.0%
4	0.8707	396.0	154° C	0.05%	92.0%	94.0%	95.0%	5.0%

* 150% excess iodine was used.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY OF ARTS,

JOHN STREET, ADELPHI, LONDON, W.C.2.
169TH SESSION, 1922-23.

Arrangements for Meetings during January, 1923.

Wednesday, Jan. 17th, 8 p.m. (Ordinary Meeting): C. A. KLEIN, *Hygienic Methods in Painting—the Damp Rubbing Down Process.* T. M .Legge, C.B.E., M.D., will preside.

Friday, Jan. 19th, 4.30 p.m. (Indian Section): THE EARL OF RONALDSHAY, G.C.I.E. (late Governor of Bengal), *A Clash of Ideals as a Cause of Indian Unrest.* The Right Hon. Viscount Peel, G.B.E., Secretary of State for India, will preside.

Wednesday, Jan. 24th, 8 p.m.: SIR WILLIAM HENRY BRAGG, K.B.E., D.Sc., F.R.S. (Quain Professor of Physics, University of London). *The New Method of Crystal Analysis, and their Bearing on Pure and Applied Science.* "Trueman Wood" Lecture. Alan A. Campbell Swinton, F.R.S., late Chairman of the Council, will preside.

Wednesday, Jan. 31st, 8 p.m. (Ordinary Meeting): THOMAS H. FAIRBROTHER, M.Sc., F.I.C., and ARNOLD RENSHAW, M.D., D.P.H., *The relation between Chemical and Antiseptic Action in the Coal Tar Dyes.*

THE FARADAY SOCIETY.

ORDINARY MEETING, MONDAY, JANUARY 15, 1923, AT 8 P.M.

At the Chemical Society, Burlington House, Piccadilly, W.1.

Papers to be read:—

E. W. J. MARDLES: *The Scattering of Light by Organosols and Gels of Cellulose Acetate.*

Study of the Reversible Sol to Gel Transition in Non-Aqueous Systems.

I. *The Change of Viscosity with Time during Gelation.*

II. *Viscosity Changes associated with the Gel to Sol Transition.*

Changes of Volume and Refractive Index associated with (a) The Formation of Organosols an dGels. (b) The Reversible sol to gel Transition.

PROF. J. R. PARTINGTON and W. G. SHILLING: *The Variation of the Specific Heat of Air with Temperature.*

PROF. A. W. PORTER and J. J. HEDGES: *The Law of Distribution of Particles in Colloidal Suspensions, with Special Reference to Perrin's Investigations.* Part II.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

1st January, 1923.

MEETING AT NOTTINGHAM.

A Joint Meeting of the Society, with the Nottingham Section of the Society of Chemical Industry, will be held at the University College, Nottingham, on Wednesday, January 17th, at 7.15 p.m.

The chair will be taken by the Chairman of the Nottingham Section of the Society of Chemical Industry, Mr. S. F. Burford, F.I.C.

A general discussion on: *The Detection and Determination of Small Quantities of Arsenic,* will be opened by Mr. A. Chaston Chapman, F.R.S., President of the Institute of Chemistry.

Mr. J. M. Wilkie will read a paper on the subject, and among those taking part in the discussion will be: Mr. S. R. Trotman, Mr. H. Droop Richmond, and Dr. G. W. Monier-Williams. The Chairman will call upon further speakers by name, and those desiring to contribute to the discussion should communicate with the Honorary Secretary.

Apparatus for the electrolytic determination of arsenic will be exhibited by Dr. G. W. Monier-Williams and Mr. J. M. Wilkie.

In order to promote a free discussion, the meeting will be private, and closed to the Press, but an official summary will be issued subsequently.

MINERALOGICAL SOCIETY.

TUESDAY, JANUARY 9, AT 5.30.

A. BRAMMALL and H. F. HARWOOD: *Dartmoor Granite, (a) Rutile, Brookite and Anatase: Genesis; (b) Varieties of Zircon: their significance.*

DR. A. HUTCHINSON: *A graphical method of correcting specific gravity determinations.*

DR. L. J. SPENCER (with microscopical determinations by W. CAMPBELL SMITH, and chemical analyses by E. D. MOUNTAIN): *A davyne-like minera land its pseudomorphs from St. John's Island, Egypt.*

We have been asked to make known that the membership of the American Chemical Society is open to members of any of the recognised English chemical societies.

Forms for membership and full particulars will be sent on application to the Secretary, American Chemical Society, 1,709, G. Street, N.W. Washington D.C., U.S.A.

BOOKS RECEIVED.

Formulary of the Parisian Perfumier, by R. M. GATTEFOSSE. Pp. 82. 1st English Edition. 1923. La Parfumerie Moderne, 39, Rue Camille, Lyon.

Cements and Artificial Stone (a descriptive Catalogue of the specimens in the Sedgwick Museum, Campridge), by JOHN WATSON (late) HON. M.A., F.G.S. Pp. XII. + 131. 1922. W. Heffer & Sons, Ltd., Cambridge. 6s. net.

A PRELIMINARY STUDY OF ZIRKITE ORE.

By J. G. THOMPSON.

(From the Journal of Physical Chemistry, New York, December, 1922.)

(Continued from Page 15.)

Zirconium was discovered by Klaproth in 1789; but, for many years after its discovery, it was considered one of the rare earths, and occasional samples of zircon, the orthosilicate of zirconium, were the only sources of supply. At present deposits of zircon sands, usually associated with monazite sands, are known to exist in many localities, but the deposits usually are of limited extent and the zircon content is small. Zirconium also occurs in small amounts in a number of rare ores, but these are important only for the traces of radio-active elements which they contain. Present interest centres solely upon the oxide ores of zirconium generally known as "Baddeleyite" ores. This group includes a number of ores of indefinite and variable composition in which the zirconium oxide content varies up to 99 per cent. The name "Zirkite" has been restricted to the baddeleyite ore from the huge Brazilian deposits which now supply practically all of the demand for zirconium. Zirkite ore is variable in composition, but careful sorting at the mine furnishes a product which is fairly uniform in composition averaging about 80 per cent. zirconium oxide. It is stated[2] that an unlimited supply of this ore is available, as the deposits are of vast extent. The only factors limiting the output are the difficulties due to primitive methods of mining and transportation.

The use of zirconium oxide always has depended upon its refractory properties; but this use, until recently, was confined to the small amounts of very pure material required for the incandescent element in the Nernst, Drummond, and Bleriot lamps; as an additional element mixed with the thoria and ceria in Welsbach mantles; etc. The discovery of the huge Brazilian deposits of high-grade ore has awakened much interest in the possibility of using this ore on a large scale as a refractory.

Many of the properties of the raw ore[3] are comparable with those of the pure oxide, but the melting point (2,950°-3,000° C. for Pure ZrO_2) drops to 1,200°-2,000° C. for the raw ore, depending upon the composition. Zirkite is an excellent refractory within the limits set by its softening and melting points, but the low melting point obviously detracts greatly from the refractory value of the ore. It has been used successfully as raw material in the manufacture of combustion boats, tubes, etc., for high temperature work in the laboratory; but the successful use of the material on a large scale awaits the development of means of raising the melting point.

The problem obviously is the elimination of the element or elements which exert so detrimental an effect upon the melting point of the ore. No definite information is available regarding the specific effect of the various impurities upon the melting point of pure zirconium oxide, but silicon and iron, which together constitute the bulk of the impurities, naturally are regarded as the chief sources of trouble.

Methods of purification, as recorded in the literature, may be divided into two classes:

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[2] *Meyer*: *Foote Mineral Company publication for November*, 1916.

[3] *Meyer*: *Met. Chem. Eng.*, 1914, XII., 791; *Audley*: *Trans. Eng. Ceram. Soc.*, 1917, XVI., 121; *Rosenhain*: *Trans. Faraday Soc.*, 1917, XII., 178; *Devereux*: *Met. Ind.*, 1920, XVI., 414.

(1) Methods for the preparation of pure zirconium compounds.[4]

(2) *Methods for partial purification of* the ore by elimination of impurities, either by leaching[5] or by volatilization.[6]

Those methods in the first class which are *successful* are *adaptable only for the* production in the laboratory of small *amounts of pure zirconium compounds.* The methods in class two have been confined almost entirely to the removal of iron. The refractory silicates of zirconium were not affected at the relatively low temperatures used in Phillips' chlorination experiments and are not susceptible to leaching unless they have been recomposed by a preliminary fusion.[7] The methods in this class are better adapted for large scale operation but are successful only to a limited extent in producing satisfactory refractory material from the raw ore.

The remarkable stability at high temperatures of certain compounds of zirconium, particularly the oxide and carbide, together with the fact that these compounds are not appreciably volatile below their decomposition points, suggested the use of electric heating as a means of purifying *zirkite ore by the elimination* of impurities whose oxides and carbides presumably are less refractory than the corresponding *zirconium* compounds. Hitherto the electric furnace has been employed[8] only as a preliminary step in the purification of zirkite, apparently for the sole purpose of decomposing refractory silicates. This investigation, therefore, was undertaken for the sake of ascertaining to what *extent zirkite might be freed from impurities* by direct heating in an electric furnace.

Before the experimental portion of this investigation could be undertaken, a scheme of analysis had to be outlined. A search of the literature revealed many conflicting statements, and considerable time was devoted to the investigation of the various methods before a satisfactory scheme was obtained. A brief, critical review of some of the methods proposed, together with a description of the scheme adopted, is therefore included in this report.

THE ANALYSIS OF ZIRCONIUM COMPOUNDS.

The characteristic properties of zirconium ores which make them valuable, *i.e.*, the refractory properties and chemical inertness, formed the first obstacles to be overcome in the decomposition of the ore.

Four general methods of attack have been proposed:

(1) Fusion with hydrofluoric acid or with fluorides.[9]

(2) Conversion to carbides in the electric furnace.[10]

(3) Fusion with sulphuric acid or its derivatives.[11]

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[4] *Berlin: Jour. prakt. Chem.*, 1853, LVIII., 147; *Hermann: Ibid.*, 1866, XCVII., 330, 340; *Bailey: Chem. News*, 1886, LIII., 55, 260, 287; *Doremus: Jour. Am. Chem. Soc.*, 1886, VIII., 91; *Bayer: Zeit. angew. Chem.*, 1910, XXIII., 485; *Anonymous: Ceramique*, 1911, XIV., 204; *Loveman: U.S. Patent No.* 1,261,984, 1918; *Imray: British Patent No.* 16,555, 1913; *Leuchs: German Patent No.* 285,344, 1914; *Meyer: loc. cit., and Granger: loc. cit.*

[5] *Wedekind: Zeit. angew Chem.*, 1908, XXI., 2270; *Weiss and Lehmann: Zeit. anorg. Chem.*, 1909, LXV., 178; *Wedekind: Ber. deutsch. chem. Ges.*, 1910, XLIII., 290; *Ramsden: Met. Ind.*, 1920, XVI., 3; *Audley; Granger; Rosen: loc. cit.*

[6] *Phillips: Jour. Am. Ceramic Soc.*, 1918, I., 791.

[7] *Weiss and Lehmann: loc. cit., Jost and Plocker: German Patent No.* 285,981, 1914

[8] *Moissan: Comptes rendus*, 1893, CXVI., 1222; *Troost: Ibid.*, 1893, CXVI., 1428; *Podszus: Jour. Soc. Chem. Ind.*, 1917, XXXVI., 217; *Barton: U.S. Patent No.* 1,342,084, 1920; *Weiss and Lenmann: loc. cit.*

[9] *Marignac: Ann. Chim. Phys.*, 1860 (3), LX., 260; *Weiss and Neumann: Zeit. anorg. Chem.*, 1909, LXV., 248; *Anonymous: The Brass World*, 1911, VII., 46; *Meyer: Foote Mineral Company Publication for November*, 1916; *Weiss and Lehmann: loc. cit.*

[10] *Granger: Moissan; Podszus; Troost; Weiss and Lehmann: loc. cit.*

[11] *Baskerville: Jour. Am. Chem. Soc.*, 1894, XVI., 475; *Dittrich and Freund: Zeit. anorg. Chem.*, 1907, LVI., 337; *Weiss: Ibid.*, 1910, LXVII., 456; *Wedekind: Ber. deutsch. chem. Ges.*, 1910, XLIII., 290; *Johnstone: "The Rare Earth Industry,"* 1915; *Powell and Schoeller: Analyst*, 1919, XLIV., 397; *Weiss and Lehmann; Bayer: loc. cit.*

(4) *Fusion with alkalies.*[12]

Fusion with sodium tetraborate (borax) was found to furnish the best means for the decomposition of the materials encountered in this investigation. Borax fusions usually produce complete decomposition in one operation, but the boric acid must be eliminated thereafter if a complete analysis is desired. Fusion with alkalies produces decomposition of the silicates and phosphates, but is not applicable to oxide ores. Fusion with pyrosulphates decomposes oxide ores, bu tis not applicable to silicates. Methods involving fusion with fluorides or conversion to carbides in the electric furnaces are objectionable on account of loss through volatilisation. A combination of alkali fusions, followed or preceded by pyrosulphate fusions, eventually produces complete decomposition and total solution of any zirconium compound, but the procedure is tedious and involved. In all cases the method employed for decomposition is determined by the nature and characteristics of the material.

After the ore has been decomposed by fusion methods and brought into complete solution, the problem of the separation of the various elements arises.

ANALYTICAL SEPARATIONS.

Silicon is removed from the solution without difficulty owing to the insolubility in acids of its dehydrated oxide.

Iron interferes with almost all of the methods for the precipitation of zirconium from solution, and should be removed before such precipitation is attempted. Leaching of freshly precipitated or ignited oxides by acid solutions, including oxalic and sulphurous acids[13] is not successful.[14] Smith[15] claims to have effected complete separation of iron and zirconium by electrolytic methods, using a mercury cathode, and Price[16] records the formation of soluble perzirkonates by methods which would leave the iron insoluble. Neither of these results could be duplicated during this investigation.

Only two really successful methods have been devised for the separation of iron from solutions containing zirconium. These are based, respectively, upon selective solubility of ferric chloride in ether,[17] and the fact that iron is and zirconium is not precipitated by hydrogen sulphide from ammoniacal solutions containing tartaric acid.[18] The ether separation method is the better of the two for the removal of large amounts of iron such as are encountered in the analysis of zirconium steels or ferro-zirconium. The precipitation method is not as satisfactory for the removal of large amounts of iron, owing to the difficulties encountered in handling large volumes of precipitated ferrous sulphide. It is indispensable, however, for the removal of the traces of iron which almost invariably survive the ether separation, and is adaptable for the analysis of zirconium ores in which the iron oxide content does not greatly exceed five per cent.

A few attempts to precipitate zirconium and titanium separately are recorded in the literature,[19] but the success of some of these attempts has been questioned.[20] For analytical purposes the separation of zirconium from titanium is unnecessary, as titanium is readily determined by Weller's[21] colorimetric method using hydrogen peroxide. The presence of zirconium does not interfere with this determination.

A variety of methods have been proposed for the simultaneous precipitation of zirconium and titanium. Dittrich and

[12] *Jewett*: "*Bibliography of Zirconium*," 1893; *Dennis and Spencer*: *Jour. Am. Chem. Soc.*, 1896, XVIII., 674; *Abegg*: *Handbuch*, 1913, IV., 490; *Schiötz*: *Chem. Abstracts*, 1918, XII., 661; *Travers*: *Chim. Ind.*, 1919, II., 385; *Lundell and Knowles*: *Jour. Am. Chem. Soc.*, 1920, XLII., 1439; *Bayer*; *Berlin*; *Johnstone*; *Powell and Schoeller*: *loc. cit.*

[13] *Dubois and Silveira*: *Ann. Chim. Phys.*, 1820 (1) XIV., 110; *Berthier*: *Ibid.*, 1832, (2) L., 362; *Wunder and Jeanneret*: *Zeit. analyt. Chem.*, 1911, L., 733.

[14] *Berlin*; *Hermann*: *loc. cit.*

[15] *Smith*: "*Electro-Analysis*," 1911.

[16] *Price*: "*Per-Acids and Their Salts*," 1912.

[17] *Noyes, Bray and Spear*: *Jour. Am. Chem. Soc.*, 1908, XXX., 481.

[18] *Wedekind*: *loc. cit.*

[19] *Bailey*: *Jour. Chem. Soc.*, 1886, XLIX., 149; *Crookes*: "*Select Methods in Chemical Analysis*," 1894; *Dittrich and Freund*: *loc. cit.*; *Browning, Simpson and Porter*: *Am. Jour. Science*, 1916, XLII., 106; *Headden*: *Chem. Abstracts*, 1917, XI., 2311.

[20] *Matthews*: *Jour. Am. Chem. Soc.*, 1898, XX., 815; *Weiss and Lehmann*: *loc. cit.*

[21] *Weller*: *Ber. deutsch. chem. Ges.*, 1882, XV., 2599.

Freund[22] claim that sodium acetate will produce complete precipitation of zirconium and titanium. The use of sulphurous acid or its derivatives has been proposed,[23] but Johnstone[24] says that this reagent also precipitates some of the rare earths as well as traces of iron and aluminum, and Hermann[25] reports that the separation resulting from the use of sulphur dioxide is not satisfactory. A number of these separations were attempted during the present investigation with complete lack of success. The manipulation is tedious, precipitation seldom is complete, and the precipitate usually is badly contaminated. Precipitation of zirconium and titanium by weak organic bases has been recommended,[26] and a number of these precipitations were attempted, using phenylhydrazine as the most promising member of this class. The experiments uniformly were unsuccessful, the precipitation was slow and incomplete, and the precipitate usually was contaminated. Variations of Hillebrand's method for the precipitation of zirconium phosphate[27] have been recommended. Lundell and Knowles[28] discuss the method in detail, and point out that the variations in composition of the precipitate prevent the use of the method except for very small amounts of zirconium.

The most satisfactory method for the analytical determination of zirconium and titanium was found to be precipitation by cupferron, the ammonium salt of nitrosophenylhydroxylamine. The use of this reagent has been proposed by several authors,[29] and has been recommended recently by Lundell and Knowles,[30] who discuss the method in detail, including a list of the elements which interfere with the precipitation and a discussion of the precautions which must be observed.

The filtrate from the cupferron precipitation contains the aluminum, rare earths, and traces of other elements. The scheme of separation for the elements in this filtrate depends upon the nature and number of elements present, as determined in the preliminary qualitative examination.

From the foregoing data a complete scheme of analysis, adaptable to low-phosphorus baddeleyite ore, was evolved. In view of the time and labour required for a complete analysis, a modified scheme was adopted for the numerous analyses which attended the progress of this investigation. This modified scheme allows only the determination of silicon, iron, titanium, and zirconium, as follows:

MODIFIED SCHEME FOR ROUTINE ANALYSIS.

The sample is ground to 80-100 mesh. 0.5 gram of the sample si weighed out and fused[31] in platinum with 5 grams of borax until a clear, fused mass results. When fusion is complete (usually requiring about one-half hour at the full heat of a Meker burner) the crucible is removed from the flame. While solidification of the melt is taking place, the crucible is kept in motion so that when cold the fusion is distributed around the sides of the crucible. The cooled melt is dissolved in 5 per cent. hydrochloric acid in a porcelain casserole, solution being hastened by gentle warming. When solution is complete, the crucible is removed and rinsed out, 10-15 cc. concen-

[22] *Dittrich and Freund: loc. cit.*

[23] *Berthier: Ann. Chim. Phys.*, 1832, (2) L., *362; 1843, (3) VII., 84; Chancel: Jour. prakt. Chem.*, 1858, LXXIV., 471; *Imray: Jour. Soc. Chem. Ind.*, 1890, IX., 941; *Trautmann: Zeit. angew. Chem.*, 1911, XXIV., 62; *Baskerville; Dittrich and Freund; Weiss and Lehmann; Travers; Granger; Powell and Schoeller: loc. cit.*

[24] *Johnstone: loc. cit.*

[25] *Hermann: Ibid.*

[26] *Hess and Campbell: Jour. Am. Chem. Soc.*, 1899, XXI., 776; *Jefferson: Ibid.*, 1902, XXIV., 540; *Allen: Ibid.*, 1903, XXV., 421; *Hartwell: Ibid.*, 1903, XXV., 1128.

[27] *Hillebrand: U.S. Geol. Survey, Bull. No.* CXLVIII.; *Biltz and Mecklenburg: Zeit. angew. Chem.*, 1912, XXV., 2110; *Ferguson: Eng. Min. Jour.*, 1918, CVI., 356, 793; *Steiger: Jour. Wash. Acad. Sci.*, 1918, VIII., 637; *Nicolardot and Reglade: Comptes rendus*, 1919, CLXVIII., 348; *Browning, Simpson and Porter: loc. cit.; Schiotz: loc. cit.*

[28] *Lundell and Knowles: Jour. Am. Chem. Soc.*, 1919, XLI., 1801.

[29] *Ferrari: Chem. Abstracts*, 1915, IX., 1019; *Thornton and Hayden: Am. Jour. Sci.*, 1914, XXXVIII., 137; *Thornton: Ibid.*, 1916, XLII., 151; *Brown: Jour. Am. Chem. Soc.*, 1917, XXXIX., 2358.

[30] *Lundell and Knowles: Jour. Ind. Eng. Chem.*, 1920, XII., 344.

[31] *The usual practice is to dehydrate the borax in the crucible, add the weighed sample, and proceed with the fusion. Carbide samples should be ignited to the oxides before attempting the fusion.*

trated sulphuric acid are added, and the solution is evaporated on a hot plate until fumes of sulphur trioxide appear. The final fuming is done over a free flame, agitating the solution to prevent spattering. The residue is cooled, dissolved by diluting with water, and filtered. The precipitate on the filter is washed with hot water, ignited, weighed, treated with hydrofluoric and sulphuric acids, again ignited and weighed, and the loss of silica determined. A slight residue, mainly iron, is recovered by fusion with pyrosulphate and added to the original filtrate.

The filtrate from the removal of silica is diluted to about 500 cc., precipitated with ammonia, and boiled to coagulate the precipitate. After settling, the supernatant liquid is decanted as completely as possible to remove the bulk of the alkalis and boron. The ammonia precipitate is redissolved by adding 5-10 cc. of concentrated sulphuric acid. One gram of tartaric acid is added, and the solution is made distinctly ammoniacal. The volume of the solution at this point should be 150-200 cc. The solution is treated with hydrogen sulphide for twenty minutes, boiled for 3-4 minutes, allowed to cool, and filtered. The precipitate is covered and allowed to drain thoroughly, but is not washed, owing to the decided tendency of the ferrous sulphide to pass through the filter when any washing solution is used. The filtrate is subjected to a second precipitation with hydrogen sulphide, and is again boiled and filtered. The two precipitates of ferrous sulphide are redissolved in dilute *aqua regia* and the iron is determined gravimetrically. The presence of hydrochloric acid and small amounts of organic matter (from the tartaric acid) precludes the determination of iron by volumetric methods.

The filtrate from the removal of ferrous sulphide, boiled to remove most of the hydrogen sulphide, is made acid with a known excess of sulphuric acid, boiled again, and the precipitated sulphur filtered off and discarded. The filtrate is cooled, diluted to 600 cc. containing 7.5-10 per cent. free sulphuric acid, chilled in ice water, and precipitated by the addition of a cold 6 per cent. aqueous solution of cupferron. During this precipitation the temperature must not exceed 15° C. The precipitate is allowed to stand one-half hour, and is then filtered, using gentle suction and washing with cold 5 per cent. hydrochloric acid. The filtrate and washings are discarded. The precipitate is ignited and weighed as ZrO_2 + TiO_2.[32] The weighed precipitate is fused with pyrosulphate, dissolved in 5 per cent. sulphuric acid, and the titanium determined colorimetrically.

On account of the variable amounts of carbon in the different samples, the analytical results were computed to a metallic basis, and the ratio of the elements determined on the basis of 100 parts of metallic zirconium. For the comparison of the various electric furnace products a study of this ratio is more easily understood than a study of the percentage composition of the samples.

EXPERIMENTAL.

The zirconium ore employed in this investigation was a finely ground zirkite, 65 per cent. of which passed through a 100-mesh sieve. Duplicate analyses of ignited samples of the ore gave the following composition:

	Per cent.	Per cent.
ZrO_2	72.55	72.78
SiO_2	17.34	17.26
Fe_2O_3	4.11	4.14
TiO_2	0.80	0.81
Al_2O_3	5.28	5.91
Rare Earths (cerium group)	1.04	1.13
P_2O_5	0.49	0.45
MnO_2	0.25	0.27
MgO	trace	trace
Total	101.86	102.75[33]
Loss on ignition ...	2.88	2.88

Ratio, on a metallic basis, of the elements present in the ore:

100 Zr : 15.1 Si : 5.37 Fe : 0.89 Ti

[32] *Any iron which escapes the precipitation with hydrogen sulphide will appear in this precipitate. Experience has shown, however, that the amount of iron which survives a double precipitation with hydrogen sulphide is so small that it may be disregarded for all except the most exact determinations. The colour of this ignited precipitate is a reliable indicator of the composition. A pure white colour indicates that zirconium alone is present. Titanium produces a yellow colour, and a reddish or brownish tinge indicates the presence of iron.*

[33] *The error in the analyses probably is due to adsorption of alkalis by the cupferron precipitate; but may be due in part to the existence in the ore of elements, e.g., iron and manganese, in different states of oxidation than the ones represented in the above table. The composition of the silicates of zirconium, which occur in zirkite ore, has not been determined definitely.*

Owing to the time and labour consumed by the necessary analytical work, it was decided to limit this investigation to the three impurities, silicon, iron and titanium. Since silicon is present in far larger amounts than any other impurity, this investigation was directed primarily towards the elimination of silicon. The removal of iron is a secondary object of the investigation.

Two possibilities were considered for the removal of silicon and iron in the electric furnace:

(1) Reduction of the oxides to the metals in the presence of an excess of iron, forming ferro-silicon which could be removed subsequently by mechanical means.

(2) Reduction of the oxides to the metals or carbides with subsequent volatilisation resulting from the application of higher temperatures.

The first method was tried out in a small crucible furnace heated by a direct arc. Iron oxide was added to the charge in an amount sufficient to unite with all of the silicon to form ferro-silicon containing 50 per cent. iron. Several runs were made, but no evidence of the formation of ferro-silicon was obtained. In every case the iron and silicon remained distributed uniformly throughout the charge, probably on account of the high viscosity of the melt which prevented the desired formation and coalescence of ferro-silicon. Increasing the temperature would increase the fluidity of the melt, and a point might be reached at which the ferro-silicon would coalesce and settle out. The indications are, however, that the desired degree of fluidity would not be reached below the temperature at which silicon becomes volatile. If it is necessary to employ temperatures high enough to cause at least partial volatilisation of the impurities, it would seem advisable to rely wholly upon volatilisation to remove the impurities. The latter method also would avoid contaminating the ore by the addition of iron, which is necessary if the ferrosilicon scheme is followed. Accordingly, the attempts to eliminate silicon and iron, as ferro-silicon, were abandoned in favour of attempts to volatilise the impurities directly.

Preliminary experiments conducted in a small arc furnace indicated that zirconium carbide is stable at temperatures above the [illegible] point of silicon carbide (carborundum).[34] This led to the belief that conversion of the entire ore to carbides, followed by the exposure of the mixed carbides to temperatures above 2,220° C., at which temperature silicon carbide decomposes, would eliminate silicon and perhaps some or all of the iron and other impurities. If this elimination of impurities were successful, it would then be possible to inite the zirconium carbide to the oxide, thus producing pure and highly refractory zirconia.

The first experiments were carried out in a furnace of the silicon carbide type, sufficient carbon being added to ensure the transformation of all the oxides present into carbides. Later experiments were performed in an arc furnace, the amount of carbon being varied rom run to run.

EXPERIMENTS WITH A RESISTANCE FURNACE.

The resistance furnace was built in the form of a rectangular trough 7 inches wide at the bottom, 8 inches wide at the top, 9 inches deep, and 29 inches long. The floor was built of zirkite brick supported by a double layer of fire brick. The sides were built of fist-size lumps of zirkite, backed with the fire brick and faced smooth with ground zirkite bonded with a little water-glass. The sides and floor were permanent. The end walls were faced with zirkite brick, which were backed up with fire brick, and were torn out after each run to facilitate removal of the charge. The electrodes were pieces of 4-inch square carbon electrodes, which entered through the centre of the end walls and protruded four inches into the furnace. The outer ends of the electrodes were water-cooled and connected to bus bars by flexible leads. Power was supplied by a 75 kilowatt motor-generator set. Two thousand amperes was the largest current available, representing the maximum ontput of the motor-generator set.

The complete conversion of 100 parts of ore to the various carbides and carbon monoixde requires approximately 33 parts of carbon. To ensure the presence of an excess of carbon, a ratio of 45 parts of carbon to 100 parts of ore was used. Petroleum coke, 10-20 mesh in fineness, supplied the carbon for most of the runs, although in one or two cases granular electrode carbon was tried.

Four runs were made in the resistance

[34] Gallett: *Jour. Phys. Chem.*, 1911, XV., 213.

furnace. Since the runs were all more or less alike, the first one only will be described in detail, as follows:

RUN 1.

Ratio of ore to carbon in charge .... 100 : 45
Total weight of charge ... 86.5 pounds
Core .... *A double line* of graphite electrode pieces, one inch in diameter ,the junctions packed in petroleum coke to ensure contact
Duration of run .... 1 hour, 52 min.
Power consumption ...... 60 K.W.H.

The charge was packed loosely in the furnace up to the level of the electrodes. The core was inserted and the remaining charge added, filling the furnace. At first it required a potential of 46 volts to produce a current of 400 amperes through the furnace. Small gas volcanoes appeared almost at once, followed by flames, bright yellow at the base, with reddish yellow tips. The power input was maintained as high as possible, being limited by the violence of the gas evolution which resulted in loss of charge when the power input became too high. After the first violent evolution of gas subsided, the charge presented the appearance of gentle boiling. After half an hour, when the total power input had reached 15 K.W.H., one end of the charge ceased boiling and settled to form a crust. This effect spread gradually until the entire charge was crusted over and quiet. Heating was continued about half an hour more. The entire charge finally became bright red in colour, but the temperature could not be raised further. At first the current was carried almost entirely by the core; but the charge itsel soon began to conduct with the result that the current rose and the voltage fel loff rapidly, until at the end of the run the current reached 1,750 amperes and the voltage dropped to 5. These results made it evident that the conductivity of the core and heated charge was too great to allow the input of power at a rate sufficient to produce the very high temperature desired.

When the cooled charge was examined, a greyish black granular core about 4 inches in diameter was found in the centre, extending the length of the charge between the electrodes. Small deposits of spongy material, metallic in appearance and rather bluish in colour, which subsequent examination proved to be zirconium carbide, were found in close proximity to the original core. The total weight of "sponge" was about six pounds. The remaining contents of the furnace consisted of unchanged charge. The original graphite core was not attacked, indicating the presence of an adequate supply of carbon in the charge. Some slight indications of the volatilisation of silica were found on the furnace walls, but the power input evidently was too low.

The three subsequent runs were made in an attempt to increase the power input, but without marked success. The results of the four runs may be summarised as follows:

TABLE I.

K.W.H.	Av. Kw.	Carbide "sponge" pounds	Metal in Sponge when Zr = 100 Si	Fe	Ti
60	32	6.0	3.7	4.48	0.79
75	34	6.5	11.0	5.50	0.78
100	38	10.0	12.2	7.60	0.79
80	40	7.5	5.5	2.60	0.87
		Original Ore	15.1	5.37	0.89

The behaviour of the carbide "sponge" on analysis showed that most of the silicon was present as the carbide, thus indicating that in general the temperature of the mass was not high enough to ensure the removal of the silicon by volatilisation. As the data indicate, the removal of silicon varied in a very irregular manner, being fairly complete in some cases but very incomplete in others. Other samples from portions of the charge farther removed from the core showed higher ratios of silicon to zirconium. This follows naturally, since volatilisation of silicon would occur first in the hottest portion of the charge, *i.e.*, around the core, and would be less evident in regions at a greater distance from the source of heat.

The data indicate little or no elimination of titanium or of iron, except in the fourth run, where considerable iron was apparently removed. In this run however

about 9 pounds of common salt was added to the charge resulting in the elimination of approximately half the iron, presumably through the formation of the volatile chloride. All things considered, the results obtained with the resistance furnace were unsatisfactory, and this type of furnace was abandoned in favour of one of the arc type.

EXPERIMENTS WITH AN ARC FURNACE.

The furnace shell of the arc furnace consisted of an iron pot, lined with fist-sized pieces of zirkite ore. The lining was faced smooth with ground zirkite bonded with a little water glass, and contained the same ratio of carbon to zirkite as the charge proper. The resulting hearth was cone-shaped, 8 inches in diameter at the top, 4 inches in diameter at the bottom, and 8-10 inches deep. This lining was torn out after each run to facilitate removal of the charge. The lower, horizontal electrode, composed of two 2-inch square graphite electrodes, formed the floor of the hearth, entering through a rectangular opening in the side of the cast iron pot. The upper electrode was a 4-inch square carbon electrode, suspended in a vertical position and counter-weighted to allow adjustment. Both electrodes were clamped in water-cooled electrode holders and connected to bus bars by means of flexible cables.

The first run performed in this furnace will be described in detail, as being typical of all the runs carried out subsequently.

RUN 5.

Ratio of ore to carbon in charge .... 100 : 45
Total weight of charge .... 11 pounds
Time of run .... 45 minutes
Power consumption .... 32.5 K.W.H.

The run was started by striking an arc between the bare electrodes. The walls of the cone immediately began to slag down so that the first addition of charge was made as soon as possible after starting the arc. The charge was fed in slowly and was observed to solidify when it reached the zone of the arc. During the early stages of the run the arc was smothered by the charge, but after all the charge had been added the arc was run open, and remained fairly quiet. The current was maintained at about 1,000 amperes until the evolution of fumes had almost ceased, when the arc became noisy and hard to maintain. The run was stopped when this point was reached.

The top of the charge oxidised during cooling, forming a layer of fine white oxides, below which lay a brittle, black mass weighing approximately 3.5 pounds. A sample for analysis was taken from the centre of this cake, and gave the following ratio:

100 Zr: 4.85 Si: 6.38 Fe: 0.70 Ti

A series of runs was made in which the ratio of carbon (petroleum coke) to zirkite ore was varied systematically. The results are assembled in the following tables.

TABLE II.
Effect of Varying Ratio of Ore to Carbon.

Run	Charge Pounds	Carbon per 100 ore	K.W.H.	Yield purified product pounds
5	11.0	45	32.5	3.5
9	12.5	25	18.25	3.0
10	12.0	20	17.5	3.1
11	15.4	15	21.5	5.0
18	15.4	10	19.3	7.0
19	16.8	5	27.0	9.9

Metal Ratio in Product.

Run	Zr	Si	Fe	Ti
5	100	4.85	6.38	0.70
9	100	3.03	6.50	0.64
10	100	2.21	5.00	0.55
11	100	0.88	5.92	0.70
18	100	1.31	8.73	0.69
19	100	1.86	6.67	0.78
Ore	100	15.70	5.37	0.89

TABLE III.
Elimination of Impurities.

Run	Carbon per 100 ore	Percentage elimination of Si	Fe	Ti
5	45	68	—19	21
9	25	80	—21	28
10	20	85	7	38
11	15	94	—10	21
18	10	91	—62	22
19	5	88	—24	13

The data obtained with the arc furnace show a maximum in the removal of silicon when the ratio of zirkite to carbon is 100 : 15. Calculations based on the silica content of the ore show that a little more than 10 parts of carbon to 100 parts of ore is just enough to transform all of the silica into carbide (carborundum) and carbon monoxide. We have, therefore, come to conclusion that the best high-temperature elimination of silicon is obtained when little more than enough carbon is used to form carbide with the silicon only, leaving the zirconium oxide undecomposed.

When more than 15 parts of carbon are used the elimination of silicon becomes steadily less complete. Under these circumstances it is known that zirconium carbide is actually produced in the arc. The zirconium carbide therefore appears to retain some of the silicon and the suggestion is offered that stable double carbides of silicon and zirconium may be produced or that the two carbides form solid solutions or mixed crystals. Runs in which granular electrode carbon was substituted for petroleum coke showed that better results may be obtained on a small scale with the more finely divided coke.

An interesting fact brought out by these experiments is the high melting point and stability, in a reducing atmosphere, of the carbide of zirconium. As long as there was an excess of carbon present, over and above the amount required for the complete conversion of the oxides to carbides, it was impossible to melt the product even under the direct action of a 40-50 kilowatt arc.

(To be Continued.)

BACTERICIDAL PROPERTIES OF THE PRODUCTS OF RADIUM EMANATION.

By John Albert Marshall, College of Dentistry, University of California.

*Communicated, October 7, 1922.**

The following abstract deals with a description of the use of radium therapy in periapical infections,[1] and supplements a preliminary note[2] in which it was pointed out that solutions of the products of radium emanation possess distinct bactericidal properties. Additional data have been compiled, but the analysis of them clearly indicates that with the present-day knowledge it is impossible to state definitely and conclusively why the products of the emanation produce such characteristic effects.

Although it was reported in 1909[3] that radium exerts an inhibitory influence on pathogenic and non-pathogenic organisms, no further work was done in this field until ten years later, when the former observations were confirmed.[4] Bacteria of various types were exposed to radium emanation with the result that a distinct inhibitory effect upon the cultures was observed.

In this present experiment a *solution* of the products of radium emanation is employed. The emanation tubes are usually discarded by the laboratories after they have undergone disintegration in respect to their content of gamma ray. However, they still contain in varying proportions radium A, B, C, and D. The effects which have been obtained are presumably not due to the hard gamma ray, but result in all probability from the action of the softer beta ray.

The radioactive solution is prepared as follows: a "de-emanated" emanation tube is placed in a sterilised mortar of about 20 cc. capacity, covered with Ringer's solution hand then crushed with a pestle. On account of the rapidity with which the radioactivity of this solution diminishes, it is advisable to crush the tubes immediately before use. This solution is carried directly to the infected area by means of sterile dressings. In the case of chronic or acute apical abscesses, found about the roots of teeth, the radioactive liquid is forced into the infected area through the pulp canal of the tooth and allowed to remain for 24 hours. Subsequently the dressings are removed, the canals tested for sterility and finally filled. With two possible exceptions there has been no evidence, after three years of time, of succeeding soreness or pain. The individual dosage in terms of millicuries of gamma radiation has varied from 0.046 to 0.138.

Failures in this method of treatment have been recorded, but the fact remains that sterile tests have been obtained more often by nsing the radioactive solution than in similar experiments with other antiseptic agents.

Summaries of experimental and clinical data are presented which indicate the variations in the pathology, age of patient, etiology, treatment, clinical result and laboratory findings.

In many instances tubes have been used in which de-emanation had proceeded to such a degree that it was not possible to obtain a reading by the electroscope. These

have given similar results insofar as bactericidal action is concerned, but they have not caused the soreness which sometimes accompanies the use of solutions containing a recorded amount of gamma rays.

In general the cases selected have been those in which previous treatments were without satisfactory result. Dichloramin T, formocresol beechwood cresote, phenol, and other antiseptics of a similar nature had been used without producing a noticeable change in condition. In fact, the greater majority of the cases carried a history of unsuccessful treatment. Most of them yielded to the action of the radioactive solution.

The precautionary measures which are to be observed are naturally those referring to dosage and technique of application. Severe radium burns resulted in monkeys when emanation tubes containing eighteen millicuries were sealed into pulp canals of central incisors. These burns were so extreme that the hard palate and orbit were involved. It is believed to be impracticable to use the radium except as a solution of the solids. The tubes should be thoroughly crushed under Ringer's solution exactly at the moment of use, and it has been customary to have three or four patients prepared and ready at one time in order to secure the greatest economy of material. The limited availability of de-emanated tubes except at emanation laboratories is a serious drawback to an extensive application of this therapy. However, it is planned, if funds become available, to further extend these researches to include not only additional data upon dosage, but also to report upon the application of other radioactive preparations which may be found to be more plentifully distributed.

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* *Proceedings of the National Academy of Sciences of the United States of America, November* 15, 1922.

[1] *Marshall, John A., "Radium in Periapical Infections" (in press).*

[2] *Marshall, John A., "Bactericidal Action of Solutions of Radium Emanation," Calif. State Med. J.*, Jan., 1922.

[3] *Iridell and Minett, "Notes of the Effect of Radium in Relation to Some Pathogenic and Non-Pathogenic Organisms," Lancet*, 1909, I., p. 1445.

[4] *Lequeux and Chrome, "Action of Radium on Bacteria," Arch. Memo. Obst. gynec.*, Dec., 1919, III., p. 698.

New Patents.

This list is specially compiled for the Chemical News, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

34397—Chemical and Metallurgical Corporation, Ltd.—Continuous process for conversion of lead chloride into sulphate, and recovery of hydrochloric acid. Dec. 16.

Abstract Published this Week.

Chromium Compounds.—Patent No. 187636.—A Patent has been granted to Messrs. C. K. Potter, of 1, St. George's Square, St. Annes-on-Sea, and F. Robinson, of 225, Green Lane, Bolton, both in Lancashire, for a process for the preparation of chromium compounds, such as chromium oxide, chromium sulphate, acetate, carbonate, and chloride, chrome alum, sodium and potassium chromates, iron sulphate.

Chromite is decomposed by treatment with sulphuric acid and an oxidizing agent, such as chromic acid, at a temperature above 150° C., the oxidizing agent, whether added directly to the reaction-mixture or generated *in situ* by electrolysis, being present in amount insufficient to oxidize the iron completely. The chromite may first be treated with carbonaceous matter or a gaseous reducing agent at a red heat and part of the iron then extracted with dilute acid. Under the conditions set out above, the chromium and part of the iron are converted into insoluble sulphates, from which the chromium is separated by adding a reducing agent to the diluted reaction-mixture when the ferric sulphate is reduced, leaving a residue of insoluble chromium sulphate. This compound may be decomposed by boiling in aqueous suspension with caustic alkalis or alkaline-earths, alkali sulphides or carbonates, alkaline-earth carbonates or ammonia to yield chromium hydroxide and/or basic carbonate; it may be heated with caustic soda or potash in presence of air and with the optional addition of other oxidizing agents to yield sodium or potassium chromate; or it may be boiled with strong barium-chloride or -acetate solution to yield the corresponding chromium salt and barium sulphate. Alternatively it may be dissolved in dilute sulphuric acid in presence of ferric oxide, and a small amount of oxidizing agent, and the solution, after reduction of any ferric salt formed, treated with potassium sulphate for the production of chrome alum. Instead of first separating the insoluble chromium sulphate, the mixture of insoluble chromium and iron sulphates obtained in the initial decomposition may be treated directly for the production of chromium oxide. In one process the mixed sulphates are washed and heated with excess of coal in a reducing atmosphere, a mixture of iron sulphide and chromium oxide being obtained. In another process, the mixed sulphates are boiled with a slight excess of alkali-sulphide solution, and the black precipitate obtained ignited in a reducing atmosphere at red heat. In a third process the mixed sulphates are calcined, and the resulting oxides mixed with coal and heated in a reducing atmosphere. In each case the product is treated with acids to dissolve the iron, and the residual chromium oxide may be dissolved in sulphuric acid in presence of a small amount of oxidizing agent and used for the preparation of other chromium compounds.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

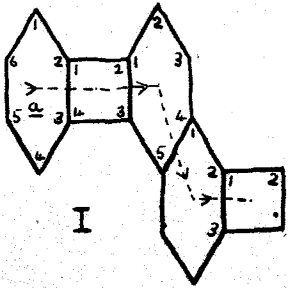
VOL. CXXVI. No. 3275.

A NEW SYSTEM FOR THE LINEAR REPRESENTATION OF THE STRUCTURE OF ALL ORGANIC COMPOUNDS.

By T. Sherlock Wheeler, B.Sc., A.R.C.Sc.I., A.I.C.

The system given below was primarily designed to enable the structure of *all* ring compounds to be represented linearly by a simple arrangement of letters and figures, from which, with the aid of a few rules, the graphical formula could be easily deduced. This is at present possible with the less complicated aliphatic compounds, *e.g.*, adipic acid can be written (COOH).CH_2.CH_2.CH_2.CH_2.(COOH); the ordinary line of type need not be disturbed to show its structure. But it is far otherwise with ring compounds, and it was a linear system for these compounds which might save the great amount of space that is now perforce devoted in chemical journals, and dictionaries, to printing their extended graphical formula, that the author first sought. In that search he was successful; as the system developed, however, it appeared it could be used equally well to represent all organic compounds, and from the representations thus obtained for any type of compound, names clearly showing the constitution could be deduced.

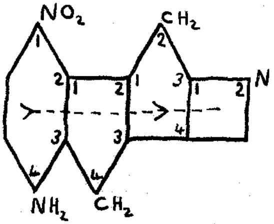
The principle of the system is best outlined by beginning with ring-compounds. I is the graphic formula of a possible aromatic hydrocarbon.



I

To represent it, the centres of the rings are joined as shown, and one supposes oneself to pass along the dotted line from "a." All rings are numbered independently and clockwise, the first ring is numbered from any carbon, in others the numbering begins on the left hand of one entering the ring along the "structure line." Then I. is Ar. VI. 2, 3 IV. 2, 3 VI. 4, 5 VI. 2, 3 IV. Ar. shows the system to be aromatic, the Roman numerals give the number of elements in each ring, and the carbons common to any ring and the next are shown, left hand carbon first, after the former's Roman numeral, by their numbers in the former. Since the "structure line" always crosses the join of the common carbons, the compound may be said to be represented by describing the course, as it were, *of its structure line.*

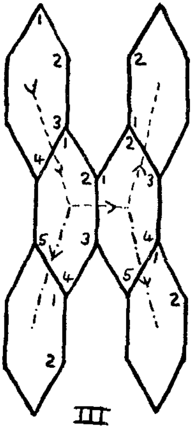
All information about any ring is given in brackets immediately after the numeral representing it. Substituents are indicated by the number of the substituted carbon *followed* by the chemical symbol of the substituent; should any of the carbons be replaced by another element, the symbol of that element comes *before* the number of its position.



II

In some aromatic compounds it may be necessary in the case of five and other odd-membered rings to show which of the carbons is saturated, *i.e.*, lack the centric bond. This is done by indicating that this particular carbon has two hydrogen atoms attached to it. II. is Ar. VI. (1-NO_2, 4-NH_2) 2, 3 V. (4=H_2) 2, 3 V. (2=H_2) 3, 4 IV. (N-2).

When branches occur in the structure line, the main structure line is given first, and then, separated by semi-colons, the various branches (shown —·—·—·—·), the rings from which these latter start being

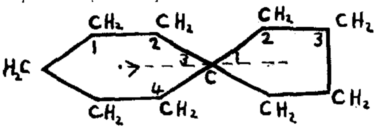


III

identified by indices. III. is Ar. VI. 3. 4 VI.′ 2, 3 VI.″ 2, 3 VI.; 4′, 5′ VI.; 4″, 5″ VI. In the main structure line it is unnecessary to attach indices to those numbers which refer in the ordinary way to the *indexed rings*.

Alicyclic compounds are prefixed by the symbol Al. In representing compounds containing both types of rings one symbol holds until cancelled by the other. Double bonds are shown in the usual way—a △ followed by the number of the carbon from which the bond begins. *Doubly linked* substituents are joined by two hyphens to the number of the carbon to which they are attached.

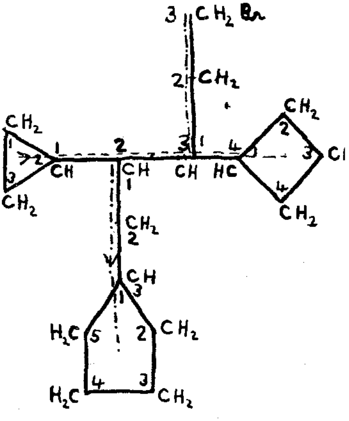
Other than ortho-fused ring systems must now be considered. IV. is a simple example of a spiro compound. It is Al. VI. 3



IV

V. The structure line is drawn through the spiro carbon and the numbering of the second ring is clockwise from that carbon. When rings are linked by chains, the structure line passes along the chain. The chain is indicated by the number of elements in it, but the Roman numeral for a chain has a bar placed over it. The chain is numbered from where the structure line enters it, and in the direction in which that line passes along it. The carbon at which the line leaves the chain is indicated as with rings: the ring to which the chain leads is numbered clockwise from where it is entered. Substituents and non-carbon elements are shown as above; the carbons common to chain and ring are numbered twice as before. The effect of the symbols Ar. and Al. is taken to persist on the far side of a chain. Branches in the chain which do not lead to rings are numbered and shown on the same plan; the structure line system is used for them as for those that are attached to rings. V. is Al. III. 2 $\overline{IV}$.′ 4 IV.; 2′ $\overline{III}$. 3 V.; 3′ $\overline{III}$. (3-Br.)

The system can now be *applied* to any open chain compound. VI. is $\overline{IX}$.′ 5 $\overline{IV}$.; 4′ $\overline{III}$. (3-Cl.) The main structure line *passes along the principle chain, then along*



V

the longest branch, and so on, being always drawn to be as long as possible. Other branches are given in

1 2 3 4 5 6 7 8 9

$\overline{CH_3.CH_2.CH_2.\quad CH\ .\quad CH\ .\ CH_2.CH_2.CH_2.CH_3.}$

$(4^1)2 \quad CH_2 \quad CH_2 \quad 2 \quad (5^1)$

$(4^2)3 \quad CH_2Cl \quad CH_2 \quad 3 \quad (5^2)$

$CH_3 \quad 4 \quad (5^3)$

Main Structure line ————————

Branch —.—.—.—.—.—.—.—.—.—.—

VI.

the order of their importance. Neglect of this rule, however, does not cause ambiguity. The Genevan system of "index numbering" for branches could be applied here. Its numbering of the chains is shown in brackets in VI. Using it, VI. would be $\overline{IX}$. (4-Et, 5-Pr, 4^2-Cl). But it is not applicable to ring compounds, and so for the sake of uniformity the structure line system is best applied right through. Also the Genevan system leads to confusion with complicated aliphatic compounds. (See *Richter*, B., XXIX. (1896), 586).

The following further examples will make the new system clear for aliphatic compounds. VII. is $\overline{IX}$. (O-3, N-7, 5-Cl 9=O, 9-OH, Δ^7)

1 2 3 4 5 6 7 8 9

$CH_2.CH_2.O.CH_2.CHCl.CH_2.N:CH.COOH.$

VII.

VIII. is $\overline{V}$. (S-3.3=O)

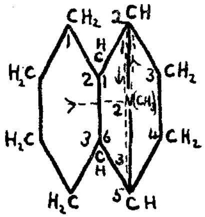
$$\begin{array}{c} O \\ \| \\ CH_3.CH_2.S.CH_2.CH_3. \end{array}$$

VIII.

IX. is $\overline{IX}$. ($\Delta^{5,8}$) 5 $\overline{(IV.)}$

IX.

It is to be noted that the carbon at which a double bond terminates need never be shown, owing to the exact indication of the chain or ring to which it belongs.



X

2 3 4

$\overline{CH_2.CH_2.CH_3.}$

$\underline{CH_3.CH_2.CH_2.CH_2 \;|\; C=CH.CH_2.CH=CH_2}$

1 2 3 4 5 6 7 8 9

(*To be Continued.*)

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY OF ARTS.

Monday, February 5, 8 p.m. (Canton Lecture): HENRY P. STEVENS, M.A., PH.D., F.I.C., *The Vulcanisation of Rubber.* (Lecture 1.)

Tuesday, February 6, 4.30 p.m. (Dominions and Colonies and Indian Sections): SIR RICHARD A. S. REDMAYNE, K.C.B., M.Sc., M.INST.C.E., M.I.M.E., F.G.S., ***The Base Metal Resources of the British Empire.***

Wednesday, February 7, 8 p.m. (Ordinary Meeting): CHARLES R. DARLING, F.INST.P., A.R.C.Sc.I., *Electrical Resistance Furnaces and their Uses.*

Monday, February 12, 8 p.m. (Canton Lecture): HENRY P. STEVENS, M.A., PH.D., F.I.C., *The Vulcanisation of Rubber.* (Lecture 2.)

Wednesday, February 14, 8 p.m. (Ordinary Meeting): W. J. REES, Lecturer on Refractories in the University of Sheffield, *Progress in the Manufacture of Refractories.*

Friday, February 16, 4.30 p.m. (Indian Section): J. T. MARTEN, I.C.S., M.A.,

Imperial Census Commissioner in India, *The Indian Census*, 1921. Sir Edward A. Gait, K.C.S.I., C.I.E., Member of the India Council, will preside.

Monday, February 19, 8 p.m. (Cantor Lecture): HENRY P. STEVENS, M.A., PH.D., F.I.C., *The Vulcanisation of Rubber.* (Lecture 3.)

Wednesday, February 21, 8 p.m. (Ordinary Meeting): C. AINSWORTH MITCHELL, M.A., F.I.C., *Handwriting and its Value as Evidence.* Sir Richard D. Muir will preside.

Wednesday, February 28, 8 p.m. (Ordinary Meeting): PROFESSOR W. E. S. TURNER, D.Sc., Head of Department of Glass Technology, The University, Sheffield, *Heat Resisting Glasses.*

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

ANNUAL GENERAL MEETING.

The Annual General Meeting of the Society will be held on Wednesday, Feb. 7, *at the Chemical Society's Rooms, Burlington House*, Piccadilly, W., at 8 p.m.

The accounts for the year will be presented, the President will deliver his annual address, and the election of officers and council for the ensuing term will take place. The appointment of auditor will also take place.

The ordinary monthly meeting of the Society will be held immediately following the Annual General Meeting, when the following papers will be read:—

Notes on the Examination of Preserved Meats, etc., by OSMAN JONES, F.I.C.

Titanium in Nile Silt, by E. GRIFFITHS-JONES.

PATENTS IN 1922.

We think it will interest everyone to know that in spite of poor trade and unemployment in 1922, Messrs. Rayner & Co., patent agents, of Chancery Lane, London, *inform us that there is an increase of more* than 300 patent applications over 1921 the figures being about 35,500, standing next to the highest in record.

The subject of "Wireless Telegraphy" shows considerable increase in the number of inventions, and after this comes reinforced concrete building construction, which is greatly practised in these days, and probably the matter of most general interest is that numerous patents have been taken in labour-saving devices for the household, and many lady inventors have come successfully into this important branch, but aviation patents have gone entirely out of favour and show a considerable decrease.

Recent months show a distinct inclination to increasing business in H.M. Patent Office, which should be an indication of better industrial times, as inventions nearly always precede improvements in commerce.

NOTICES OF BOOKS.

Formulary of the Parisian Perfumer, by R. M. GATTEFOSSE. 4th Edition. Pp. 85. Edition Parfumerie Moderne, No. 112, Route de Crénieu, Villeurbanne-lez-Lyon (France).

The fourth edition of this excellent little handbook has just been published by the [illegible] *ques, Société Française de Produits Aromati[illegible]* with [illegible] and M. Gattefossé, whose association [illegible] upon the *Société* proves him an authority [illegible] nd-perfumes, has maintained his high sta[illegible] pre-ard. As the author explained in his [illegible] in-face, the work *is one calculated to be* [illegible] nd valuable to extensive manufacturers a[illegible] es lesser specialists alike. Part I. embodi[illegible] of the classification, extraction, and testing [illegible] of essential oils and the concentration [illegible] e flower juices; the principles of perfum[illegible] composition; and exhaustive formulæ and lists of fixators and resindors. Part II. is more practical, and contains two recipes for [illegible] eau de Cologne, three for dentifrices, an[illegible] three for toilet lotions; as well as the com[illegible] ponents of cold cream, brilliantines, an[illegible] cosmetics. Considering that the volume only comprises 82 pp., it is extraordinarily comprehensive. Not only does it cover a wide field, but the matter contained has been carefully selected and intelligently listed. If M. Gattefossé has erred at all in its compilation, it is by being a trifle too brief at the expense of coherency; although, perhaps, for purposes of rapid reference, this is an advantage. J.M.

Second Year College Chemistry and *Second Year Laboratory Manual*, by WILLIAM H. CHAPIN. Chapman & Hall. 15s. and 7s. 6d.

The author's familiarity with the modern requirements of chemical students and the

more up-to-date methods of tuition is clearly evidenced by these two books, which have just been published for the first time. The former constitutes the theory—and beliefs, but upon rudimentary fact—of not built upon a meaningless mass of rules the course; the latter, the practice. Valuable suggestions as to procedure through the course have also been incorporated. But what appear with prominence are the chapters upon ionisation, osmotic pressure, radioactivity, and the periodic system. The last-mentioned is especially enlightening, but the other three could, perhaps, be extended with advantage, as could the section upon the determination of atomic weights, although the author has quoted several works dealing exclusively with these sections. The Laboratory Manual follows closely the theoretical treatise, and the prescribed experiments are well chosen and lucidly explained. One important omission, however, is the application and modification of Avogadro's Law, dealing with gases at or near the point of liquefaction; and greater attention could have been given to ion migration under the influence of electric currents. The two books, used conjointly, would, without doubt, not only teach the student, but also compel him to feel that he has a *grip* upon his subject, inspiring him with confidence, and thus facilitating the learning-processes. This, to say the least, is a novel feature, as the majority of textbooks seem to be written diatribes of uninteresting facts and formulæ. The "tone" of the work is something unusual, and that alone should induce demonstrators to adopt it as a standard course. J.M.

LIESEGANG RINGS. I. SILVER CHROMATE IN GELATIN AND COLLOIDAL GOLD IN SILICIC ACID GEL.*

By Earl C. H. Davies.

[*Contribution from the Chemical Laboratory, West Virginia University.*]

Introduction.

It is generally agreed that while the present theories regarding Liesegang rings may cover the broad features of this phenomenon they are quite inadequate to explain its many details, complexities and variations. To study this phenomenon further, I have in the first place investigated the effect of gravity on the formation of bands of silver chromate in gelatin. In the second place, I have studied the formation of rhythmic bands of colloidal gold in silicic acid gel, since this presents an ideal opportunity for offlowing changes in the sizes of the particles.

Silver Chromate Bands in Gelatin.

Effect of Gravity.—An aqueous solution of silver nitrate was made containing 8.5 g. in 100 cc. The gel contained 4 g. of powdered gelatin, 0.12 g. of potassium dichromate, and 120 g. of water. The gelatin was boiled with the water and the dichro-

Table I.

Rate of Diffusion at 0°.

Time in days.

Tube	7 Cm.	14 Cm.	18 Cm.	20 Cm.	25 Cm.	27 Cm.	32 Cm.	34 Cm.	39 Cm.	46 Cm.
A right	6.40	9.00	The two ends had met							
A left	6.40	9.00								
A′ right	6.40	8.75								
A′ left	6.40	8.75								
B	6.40	9.25	10.60	11.29	12.62	13.10	14.35	14.80	16.25	16.5
B′	6.40	9.25	10.60	11.27	gelatin frozen					
C upper	6.40	8.68	The two ends had met							
C′ upper	6.40	9.04								
C lower	5.97	8.16								
C′ lower	5.97	8.40								
D	5.76	8.60	9.80 •		10.80	13.17		14.65		
D′	5.76	8.60	Gelatin frozen							

* From "The Journal of the American Chemical Society," December, 1922.

mate for a few minutes on a water-bath until solution had taken place, and the solution was then filtered into tubes. After it had solidified (standing over-night) and had been left in the ice-room at 0° for about 2 hours, the tubes were arranged as follows: A and A′ were horizontal with silver nitrate contact at both ends; B and B′ were horizontal with silver nitrate contact at one end; C and C′ were vertical with silver nitrate contact at both ends; D and D′ were vertical with silver nitrate at the lower ends; E and E′ were vertical with silver nitrate contact at upper ends.[1]

The results given in Table I. show that diffusion is slowest when it operates against gravity (Tube D), and that hydrostatic pressure may partially counterbalance gravity (Tube C, lower).

After the 18th day the tubes were removed from the ice-room while observations were made at room temperatures and with varying light, either artificial or sunlight. Hence the results previous to the 18th day are most satisfactory. After that elapsed time all tubes were removed for the same length of time and subjected to practically the same light and heat conditions.

Preliminary Bands.—It seems from observations so far recorded that in the case of silver chromate in gelatin the method of ring formation is: first, the silver nitrate diffuses into the gelatin and gives what seems to be an opaque region which in reality consists of small opaque bands. These preliminary bands have not been observed in the earlier stages of diffusion. Tube B′ at 13.5 to 15 cm. from the surface of entrance of the silver nitrate had 28 bands. Tube D had 16 bands at 12.8 to 13.8 cm. from the point of the beginning of the silver nitrate penetration. Tube E′ had 26 opaque bands at 10.5 to 11.5 cm. from the surface. From this point it appears that there is a tendency for the opaque bands to be closer together in the earlier stages of diffusion and to be farther apart as the distance from the surface of initial diffusion increases. It is, therefore, not unlikely that this formation of preliminary bands extends to all portions of the tube, but that the bands are at first so close that they seem to merge.

[1] *Data for E and E′ were not given in Table I. because the silver nitrate had not the same strength as that used in the other tubes.*

In the case of silver chromate in gelatin the reaction as carried out in a test-tube would be, $K_2Cr_2O_7 + H_2O + 4AgNO_3 = 2\,KNO_3 + 2\,Ag_2CrO_4 + 2\,HNO_3$. We are not dealing simply with silver chromate. and it is a well known fact that electrolytes have a profound effect on gels. They not only influence the rate of imbibition of water, but also tend to produce peptization. As the gelatin gel ordinarily used is not as dilute as possible we know that it is capable of absorbing more water. The presence of nitric acid would disturb the layer of gelatin where it is produced. There is a similar change in rate of imbibition when a base is one of the products. The potassium nitrate and nitric acid have the greatest concentration at the layer of reaction between the potassium dichromate and silver nitrate. From microscopic observations it appears that at least at 0° some of the potassium nitrate is crystallised simultaneously with the small particles of silver chromate. The nitric acid is more soluble, and hence, according to Fick's law, diffuses faster than the potassium nitrate because it is potentially more concentrated.

It is to this unequal rate of diffusion that we attribute the preliminary bands. The groups of silver chromate-potassium nitrate "crystals" are gradually broken up as the potassium nitrate diffuses away and the silver chromate particles become larger because of the oncoming silver nitrate. Hence the small bands lose their identity and the larger band is formed. Below the small band the silver nitrate and nitric acid and some potassium nitrate are diffusing into the potassium dichromate. Of course, the potassium dichromate is diffusing "up" but because of its low concentration the rate of diffusion is low.

Colloidal Gold in Silicic Acid Gel.

Light a Factor in Formation of Rythmic Bands.—To ascertain the effect of periodic illumination in the production of bands, I have carried out the following experiments, using colloidal gold in silicic acid at the concentrations suggested by H. N. Holmes,[2] who apparently carried out his experiments in changing light.

Tubes gave no bands either at 0° or at room temperatures when covered, light-

[2] *Holmes, Jour. Amer. Chem. Soc.*, 1918 XL., 187.

tight, with black paper and placed in a dark room even after 9 days. Instead, the gold precipitated in sparkling yellow particles. A band of about 1.5 cm. width was formed in these tubes by removing the black paper and exposing them to the light from a projection lantern for an hour. The band did not start as a fine line and then gradually grow; rather, it began as a faint colour thoroughout the entire region, becoming gradually more intense by longer exposure to the light until it reached a maximum at which all the gold adsorbed by the fibrils in this region had been precipitated. The colour was lighter at the top of the band and most intense near the bottom. Below the coloured zone, yellow crystals of gold could be seen for a distance of 8 to 9 mm.

Second, slits were cut in the black paper in such a way as to expose 2 mm. cover 8 mm., expose 2 mm., etc., throughout the length of a tube. This tube was placed in the dark room at a distance of 14 cm. from an 80-watt, 110-volt Mazda light. Slightly green colloidal bands developed at the openings after 9 days, and at each opening there were distinct yellow bands of gold crystals.

Third, a similar tube which had been in the dark at 0° for 6 days showed no bands at the openings. When this tube was exposed to the strong light of the projection lantern for a few minutes, bands developed at 2 of the openings in the same region as in the case of a tube which had been handled exactly similarly, except that it had no protection from the light of the lantern. Between these openings the bands did not form, although the tube was in the strong light for 1 hour. This tube was then put in the dark for 7 more days at 0°. The black slit paper was then entirely removed and the tube put in front of the lantern for 3 hours. There was a slight blue colour developed in the 8 mm. zone between these 2 bands. From the faint colour of this blue it was apparent that the light is not the only factor in promoting the band formation of the gold. There must also be proper concentrations of the oxalic acid and the gold chloride. The sodium sulphate is not included because it is presumably uniformly distributed.

Hence it seems that the molecular gold adsorbed by the walls is in some way at first protected from immediate precipitation by the oxalic acid. It is probably oriented.[3] After a time such gold is gradually precipitated in the dark, but not in bands. At some other concentrations bands may be obtained in the dark; but so far I have observed no tendency for the gold to form in bands in silicic acid except under more or less periodic light changes. For example, E. Küster[4] found under certain conditions, in the case of bands of silver chromate in gelatin, that when the silver nitrate had diffused into the gelatin in the dark there was an evenly distributed precipitate, but when the diffusion area was exposed to light rhythmically, that is, alternate exposure (25 minutes) and darkness (45 minutes) the precipitate took the characteristic ring formation. I have obtained just as good bands of silver chromate in the dark as in the light, both at 0° and at room temperature of about 20°.

Two-phase Character of Silicic Acid Gel.—It seems that the "protected" gold chloride, which we have assumed to be adsorbed by the more solid portion of the gel cells, gradually diffuses away and is precipitated if the band is not started by the light, or the peptizing and imbibition action of the products of reaction. It is because of this migration and precipitation that the null spaces are formed.

When in the dark or in mild light there is a rather broad band which forms at the top of the silicic acid layer. This band was in some cases reddish-purple in transmitted light and yellow in reflected light. Below this there were sparkling, yellow crystals of gold. These latter precede the usual bands. Observed with a powerful Tyndall cone it is seen that the particles of gold are most numerous just beneath the band. They become relatively fewer until they cease to appear at a distance of about 8 to 9 mm. Then a band begins to form in the region already best filled with the larger particles of gold. The band owes its formation to the condensation of the molecular gold to the size of colloidal particles. Much of the gold has already been precipitated as microscopic particles. Hence in the formation of these bands there comes a time when there

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[3] *For discussion of the subject of molecular orientation see Harkins, Davies and Clark, Jour. Amer. Chem. Soc.*, 1917, XXXIX., 541.

[4] *Küster, Kolloid-Z.*, 1913, XIII., 192.

is a considerable accumulation of the products of reaction, hydrochloric and carbonic acids. Also the concentration of the gold chloride becomes quite small, due to the previous precipitation of the microscopic particles. The whole experiment behaves as would be expected if the gold chloride were held in the gel in two ways. First, some of it is most free to move and forms the larger particles. Second, the accumulation of the products of reaction affects the "protective" coating on the other gold chloride molecules so that they are attacked by the oxalic acid. It would seem that these colloidal particles which form the bands must likewise be protected by the gel, as they remain unaffected by further diffusion of the electrolytes. This is what might be expected if we had films of the solid gel and pockets of the amorphous gel. W. Moeller[5] has observed such a formation in the case of gelatin, where he finds fibrils of α-gelatin imbedded in amorpbous β-gelatin.

However, the structure of the gel is not the only factor. Many experiments on band formation have been performed where gel was replaced by solids, as sand, sulphur, etc. There is also in these cases a possibility that an oriented adsorption of one of the reacting substances by the solid plays an important part. Some of the precipitate is, in nearly all cases, of a preliminary nature. It may be scattered, as in the case of gold, o rin preliminary bands, as in the case of silver chromate in gelatin. These preliminary particles may sometimes be later partially converted into colloids by the excess of electrolytes but in the case of gold there seems to be no such tendency. The gold originally precipitated as blue remains blue, the red remains red. This shows that it is formed in protective coats of the gel. Otherwise we might expect the red particles to enlarge gradually and become blue as more of the diffusion takes place. The molecu-
as the lar gold in the fibrils forms the bands. The
diffusion incic ...loride in the amorphous portion of
unlikely that the rms the granules.
bands extends to ... ands of gold observed, the red
but that the bands a ... where it has formed at all.
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[1] *Data for E and E' we...*
Table I. because the silver...
the same strength as that us... 1916, XIX., 205.
tubes.

forms. Under this same red band relatively large amounts of the yellow gold have been observed for a distance of 8 to 9 mm. beyond it. Hence, where the blue bands form there are relatively large amounts of the products of reaction, hydrochloric and carbonic acids, with relatibely high concentration of adsorbed molecular gold. Under the latter conditions we should have greater tendency for adsorption of the oxalic acid with more of the "protected" molecular gold collecting in each "protected" colloidal particle.

Effect of Temperature.—Upon a study of the literature on Liesegang ring formation one is impressed by the small attention paid to the effect of temperature. Experiments have nearly always been carried out at room temperatures. Yet it is recognised that the elasticity of gels[6] is directly related to the formation of Liesegang rings. In the present experiments with silver chromate in gelatin, the bands were closer when made at 0° than when formed at room temperatures. Particularly in the case o gelatin should studies be made at differen and regulated temperatures. Thus the ordinary gelatin gels melt between 25° and 29° depending upon the concentration. Wher working at room temperatures with a 4 pe cent. gelatin gel (m.p. about 26°), we ar very close to the limit of non-elasticity When we lower the temperature to 0° w have lowered the distance from the meltin point by several hundred per cent. There fore, we have greatly affected the elasticit and may expect marked influence on rin formation. At lower temperatures, th rate of diffusion is also lessened. It doubtful whether as low a temperature 0° is desirable, but it is certainly advisab to work at a uniform temperature not t close to the melting point of the gel. Wi the silicic acid there is not the difficulty melting at higher temperatures. In fact seems best many times to work at high temperatures; but here also conditions light and heat should be carefully regulat if the observations are to be more th qualitative.

Conclusion.—The oriented adsorption the gel or porous solid of the reacting su stances as well as the products of react have not received the attention which th deserve. On looking through the literat we find that the concepts, which exis

[6] *See Hatschek, ibid., 1914, XIV., 115*

prior to our knowledge of colloids, are carried over to explain facts which are clearly related to the phenomena of colloidality. Thus we read statements to the effect that "the ions diffuse toward each other until the solubility product is exceeded." It is not clear how this applies to the formation of bands which consist altogether of colloidal particles. The colloidal conception would be that a number of molecules, in some cases about 100 as for the usual colloidal silver, are congregated into a particle of rather definite size. If too many of the molecules collect on one "crystal" we have the usual precipitate (in our case the yellow crystals of gold). Hence it is necessary to regulate the number of these gold molecules which are reduced in a "protective" coating or pocket of the gel. Thus we are not surprised that light, heat, peptizing electrolytes and the rate of diffusion all play important roles in regulating the formation of bands and the size of particles in those bands, and in case of colloidal gold the colour which The Svedberg[7] has shown is directly related to the size of particles.

Forecast.—It seems possible to predict that subsequent experiments will show that in many cases of Liesegang rings which occur in nature light will be found to be an important factor. This is because of the natural periodicity of sunlight. Diffusion takes place at night with perhaps chemical reactions. Then in the daytime the combined action of the light and the products of the reactions is to cause a band to form where the concentrations and the nature of the diffusion medium are suitable. Further experiments will be made, especially with silicic acid gel to determine the effect of light as a factor.

"*Preliminary*" *bands* of silver chromate were observed after the diffusion in gelatin had extended 10 to 12 cm. at 0°. The presence of these is attributed to the unequal rate of diffusion of the products of reaction. About 3 of these preliminary bands gradually form the nucleus of the final band; 26 such bands were observed in a space of 1 cm. These "preliminary" bands gradually lose their identity as the silver chromate is carried to the final band by the excess of silver nitrate.

[7] Ostwald, "Theoretical and Applied Colloid Chemistry," 1st ed., 1917, p. 60.

Light is one of the most important variables in maping rhythmic bands of gold in silicic acid. At the concentrations used no bands were formed in the dark at either 0° or room temperatures. Periodic variations of strong light and darkness produce bands in those regions in which there is still adsorbed molecular gold, excess of acid and suitable amounts of the by-products of the reaction. These by-products make precipitation in bands possible because they influence the tendency toward imbibition and peptization so that the gold is precipitated in "pockets" just large enough to give a colloidal dispersion. There is no fundamental difference between the bands of blue gold and those of red. Any combination of conditions which tend to precipitate the gold from the "fibrils" in relatively large "pockets" will produce blue bands. The red bands are made when the pockets are not so large. Rhythmic bands of silver chromate form in gelatin in the dark at 0° and at room temperatures.

Silicic acid gel is a 2-phase system; the gold chloride is held in the gel in two ways. Some of it is most free to move and forms the larger yellow crystals before the bands begin to appear. The remainder of the gold chloride seems to be more "protected" by the gel. Oriented adsorption takes place at the interface between "fibrils" of α-gel and the amorphous β-gel. This oriented adsorption may set up a temporarily "passive" state, even where the adsorbed substance is not actually coated by a film of the gel. Such orientation can occur when solids such as alundum and sulphur are the mediums in which Liesegang rings are made.

At room temperatures gelatin gel is near its point of minimum elasticity. More experiments should be carried out with it at lower and uniform temperatures.

SUMMARY.

Gravity decreases the rate of diffusion upward during the formation of Liesegang rings of silver chromate in gelatin dichromate.

In conclusion the author wishes to express appreciation for the co-operation of W. B. Shirey and Professor Friend E. Clark of this Laboratory.

Morgantown, West Virginia.

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Malic, maleic and fumaric acids[1] are now available in large quantities and at comparatively low prices, and an investigation was, therefore, made to determine whether they might replace the more costly succinic acid[2] for standardising basic solutions. A. Astruc[3] has shown that when phenolphthalein is used as the indicator many of the dicarboxyl acids, including the acids mentioned above, behave as though they have 2 replaceable hydrogen atoms, whereas with methyl orange the end-point is uncertain. No methods of purification nor data of titrations were given for these acids.

In the experiments below, the sodium hydroxide solutions free from carbon dioxide were prepared in the usual manner by the addition of barium chloride, and then standardised against hydrochloric acid, the normality of which was determined by precipitation of silver chloride; the normality of the sodium hydroxide was also determined by titration with pure succinic acid.

Maleic Acid.—Commercial maleic acid was found to be too impure to use directly. The acid was, therefore, purified by crystallisation in four different ways: (1) a single crystallisation from water; (2) two crystallisations from water; (3) one crystallisation from 200 cc. of water to which had been added 4 drops of conc. nitric acid; (4) crystallisation as in (3) and then once more from pure water. After air-drying, the crystals were dried to constant weight over sulphuric acid or in an oven at 90° for 2 hours. Definite amounts of the acid were dissolved in distilled water, which was previously boiled to expel carbon dioxide and allowed to cool to about 50° before addition of the acid. In each case the standard sodium hydroxide solution was then added until the end-point with phenolphthalein was obtained. The normality of the base against standard hydrochloric acid was 0.1087 *N*; 4 titrations with succinic acid gave an average value of 0.1087 *N* with an extreme variation of ± 0.0001 *N*; the normality determined with 16 samples of maleic acid dried over sulphuric acid and varying in weight from 0.1696 to 0.2642 g. averaged 0.1088 *N* with an extreme variation of +0.0001 to -0.0003 *N*; titration with 4 samples of maleic acid dried at 90° and varying in weight from 0.1987 to 0.2339 g. gave an average value of 0.1087 *N* with an extreme variation of ± 0.0001 *N*. It was found that maleic acid, after one crystallisation from water or from water with a few drops of nitric acid, will give results as accurate as obtainable with succinic or hydrochloirc acids. Several determinations with samples of maleic acid dried at 105° and 120° showed that a small amount of maleic anhydride is formed; such samples after standing in the open air for 24 hours are hydrolysed, giving accurate results after drying again in a desiccator over sulphuric acid or in an oven at 90° and reweighing before titration.

Fumaric Acid.—Commercial fumaric acid was found to be too impure to use directly; any one of the four methods given above may be used to purify it. The normality of the base determined with 16 samples of fumaric acid dried to constant weight over sulphuric acid and varying in weight from 0.1280 to 0.4249 g., gave an average value of 0.1082 *N* with an extreme variation of +0.0003 to -0.0001 *N*; the normality of the base determined with 4 samples of succinic acid averaged 0.1081 *N* and with hydrochloric acid 0.1082 *N*. The results with fumaric acid dried for 2 hours in an oven at temperatures from 90-120° gave an average value of 0.1082 *N* with an extreme variation of +0.0002 to -0.0001 *N*. The results show that fumaric acid may serve as a standard in alkalimetry after one crystallisation from water, although a higher temperature of the solution must be maintained during the titration because of the lower solubility.

Malic Acid.—Malic acid is very soluble in water, and was therefore recrystallised by dissolving in hot acetone, filtering, and then adding carbon tetrachloride to the hot solution and allowing the acid to crystallise on cooling. The crystals were dried in air for about 24 hours and then dried in a desiccator over sulphuric acid for an equal length

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Maleic and fumaric acids are oxidised by potassium permanganate according to the following equation:[4] $C_4H_4O_4 + 5O \quad 3CO_2 + H_2O + HCOOH$. Conflicting statements are made by previous investigators concerning the quantitative course of this reaction. This work was repeated, and it was found that although *these acids may be used as* standards for permanganate solutions, they are not as accurate nor as convenient as sodium oxalate. This is due to the low hydrogen equivalent of the acids which necessitates using very small samples with the consequent greater effect of any small errors in weighing and the difficulty of titrating boiling solutions. Titrations of malic acid were conducted in the same manner but the results were too variable and inaccurate to be of any value. Experiments with maleic or fumaric acid as titrating agent with 0.1 *N* iodine solution using starch as indicator did not give accurate results.

Attempts to standardise a 0.1 *N* ammonium hydroxide solution by titrating against known weights of malic, maleic, fumaric and succinic acids using either cochineal or methyl red as indicator were not successful. Although it is evident for theoretical reasons that a sharp end-point cannot be obtained in titrating a weak acid with a weak base, nevertheless conflicting statements have been made by previous investigators on the use of succinic acid in the standardisation of ammonium hydroxide solution with cochineal as an indicator.[5]

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It is evident that malic, maleic, and fumaric acids may be used with great accuracy as standards for sodium hydroxide solutions; it is further obvious that all 3 acids *may be obtained in a pure form* very readily, and all may be dried over sulphuric acid; malic and fumaric acids may be dried for 2 hours at temperatures from 90° to 120°; because of the formation of the anhydride, samples of maleic acid should not be dried above 100°. As standards in alkalimetry and acidimetry these acids, in the pure state, are as accurate as hydrochloric acid determined gravimetrically as silver chloride. The most serviceable of these organic acids are those most soluble in water—malic and maleic acids—although they are no more accurate than fumaric acid. Although maleic and fumaric acids may be used as standards for potassium permanganate solutions, they are neither as accurate nor as convenient as sodium oxalate for this purpose. Succinic, malic, maleic, and fumaric acids cannot be used as standards for ammonium hydroxide solutions; the last 2 acids cannot be used for iodine titrations.

Cleveland, Ohio.

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(*Continued from Page* 31.)

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carbide as a refractory, however, it would be necessary to protect it from oxidation. The black carbides all burned readily in the air to form light, fluffy oxides. Heating the powdered carbides to dull redness is sufficient to start the oxidation, which then proceeds slowly but persistently.

The data show that some titanium was also eliminated but no iron, there being an apparent increase in the amount of the last impurity. This apparent increase in the iron content, especially in the case of Run 18, is due to the difficulties encountered in analysis. The samples of furnace products must be pulverised for analysis, and, since the amount of silicon present is of primary importance, grinding such abrasive material in an agate mortar is out of the question. The only other method available was the use of a cast-steel bucking board, which resulted, naturally, in contamination of the samples. In view of the time required for analysis it was not considered advisable to grind additional samples in an agate mortar for the determination of iron. From a consideration of the data in Table III., therefore, one may safely conclude only that little if any iron was eliminated under the conditions of experiment.

Other runs were made in which sodium chloride was added to the charge of ore and coke to aid in the removal of iron, but curiously enough no iron was eliminated in this way. It is possible that the rapid attainment of the high temperature under the arc decomposed the chloride before it could be volatilised away.

Since the treatment in the electric furnace was not successful in eliminating the iron, other means of accomplishing this end were sought.

Experiments on the Removal of Iron.

Different samples o fthe various electric furnace products all showed magnetic properties, due presumably to the presence of iron either as carbide or alloy. Accordingly attempts were made to use these magnetic properties as a basis of separation of the iron, but the attempts were not successful. The magnetic portions contained approximately half of the zirconium and the non-magnetic portions contained appreciable amounts of iron.

Attempts were next made to remove the iron by leaching with 5 per cent. sulphuric acid.[35] Both the carbide and the corresponding oxidised products of the electric furnace runs were leached with hot and with cold 5 per cent. sulphuric acid. The iron in the carbide appears to be more susceptible to leaching than is the iron in the oxidised material; but, even in the case of the carbide, less than half of the iron could be removed in this way.

A series of experiments was next carried out on the removal of iron by treatment of the carbides or mixed oxides with chlorine[36] at both low and high temperatures. The experiments were carried out in a small, horizontal, tube furnace, and the frequent clogging of the apparatus by the volatile products of the reactions, especially at high temperatures, showed plainly that a furnace of special design is essential for investigation of this possibility. Nevertheless, results were obtained which indicated that iron may be removed in this way from zirconium carbide at low temperatures, and, at high temperatures, from zirconium oxide from which silicon had been largely eliminated in the arc furnace. It would seem, therefore, that a fairly pure zirconia for refractory purposes might be made from crude zirkite ore by eliminating in an electric furnace as much as possible of the silicon and by following this by treatment with chlorine or phosgene[37] to remove the iron.

This investigation is admittedly incomplete in many ways. The limited time at our disposal and the difficulty of, and the time consumed by, the analytical work involved, may be offered as an excuse. It is hoped, however, that attention will be called to the problem of large-scale purification of zirconium oxide, so that the latter may become more generally available as a refractory material for very high temperatures. A summary of the results obtained follows:

Summary.

(1) Ninety to ninety-five per cent. of the silicon may be removed from siliceous zirkite ore by heating a mixture of ore carbon to a temperature greater than 2,220° C. in an electric furnace.

(2) The best results appear to be ob-

[35] *Barton: loc. cit.*
[36] *Phillips: loc cit.*
[37] *Baskerville: Science*, 1919, L., 443.

tained by feeding into an arc furnace a mixture of ore and coke, the amount of carbon being approximately that required to transform only the silicon to the carbide.

(3) The eixstence of stable double carbides of silicon and zirconinm, or of solutions of silicon carbide in solid zirconium carbide, has been suggested as an explanation of the incomplete removal of silicon when carbon in excess of that required to form only silicon carbide is used.

(4) It is suggested that zirconia sufficiently pure for refractory purposes might be obtained from zirkite ore by removing the silicon in an electric furnace and following this treatment with chlorine or phosgene to remove the iron.

(5) Attention has been called to the refractory properties of zirconium carbide and the factors which limit its use.

(6) Methods of analysis of zirconium compounds have been reviewed briefly and a modified scheme of analysis has been outlined for the determination of zirconium and the three major impurities, silicon, iron, and titanium.

Cornell University, 1920.

THE ODOUROUS CONSTITUENTS OF APPLES. II.* EVIDENCE OF THE PRESENCE OF GERANIOL.*

By Frederick B. Power and Victor K. Chesnut.

Contribution from the Phytochemical Laboratory of the Bureau of Chemistry, United States Department of Agriculture.]

In a previous communication[1] it was shown from the results of a somewhat extended investigation that the odourous constituents of the apple consist chiefly of the amyl esters of formic, acetic and caproic acids, with a very small amount of the caprylic ester and a considerable proportion of acetaldehyde. It has, however, been noticed by us and remarked by others that, in addition to the odour imparted by the above-mentioned esters, some particularly choice varieties of the apple have a distinctly rose-like odour. We had furthermore observed in the previous investigations that when the esters contained in a concentrated distillate from apple parings were hydrolysed, the alcoholic product so obtained possessed an odour which was more pleasant than that of pure amyl alcohol, although the presence of the latter in predominating amount was completely established. It was thus evident that the amyl alcohol was accompanied by a relatively small proportion of another substance of alcoholic nature, but the amount of material available did not permit of its identification. The odour of the above-mentioned hydrolytic product had suggested the possibility of the presence of the aliphatic terpene alcohol geraniol, $C_{10}H_{18}O$, which is known to possess a rose-like fragrance, and the correctness of this supposition has been confirmed by the results of the present investigation.

Experimental.

In order to accomplish the particular purpose in view it was desirable to employ one of the most fragrant varieties of the apple, and the well-known McIntosh apple was consequently selected. The fruit was obtained from the Boston market and, as in the previous investigations, only the parings were used. The separation of the thin rind was accomplished by means of a machine, which was so adjusted as to remove only a very small portion of the white substance of the apple. By some preliminary weighings it was found that the proportion of the fresh parings to the entire fruit was approximately 12.5 per cent.

Extraction of the Essential Oil

From Apple Parings.—A quantity (31.75 kg.) of the apple parings, without any further addition of water, was subjected to distillation with steam and 76 litres of distillate collected. The entire distillate was then cohobated in a current of steam until the odourous constituents were finally contained in a volume of 0.5 litre. This concentrated liquid was extracted five times successively with ether, the ethereal liquids being then dried with anhydrous sodium sulphate, and the greater part of the solvent removed by distillation. The remaining liquid was allowed to evaporate spontaneously in a small, tared flask, until the residue was of practically constant weight.

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* From "The Journal of the American Chemical Society, December, 1922.

[1] Power and Chesnut, Jour. Am. Chem. Soc., 1920, XLII., 1509.

A pale yellow, somewhat viscid oil was thus obtained, which had a fragrant and characteristic apple-like odour. The amount of this product was 0.6977 g., which corresponds to 0.0022 per cent. of the apple parings, or about 0.00027 per cent. of the entire fruit. This essential oil gave very slight reactions for acetaldehyde and for furfural, and was similar in its general characters to the analogous products from other varieties of the apple which the present authors have previously described.[1]

From Apple Pulp.—In order to ascertain whether any appreciable amount of essential oil is contained in the fruit after the removal of the rind, an experiment was conducted with a small quantity of the same lot of McIntosh apples as that used for the main investigation. The fruit, after being pared by means of a machine, was cut into quarter sections, and the core and seeds completely removed. This material, amounting to 5 kg., was then distilled in a current of steam, and about 3 litres of distillate collected. The slightly opalescent, neutral liquid was less fragrant than the distillate from the parings, the odour somewhat resembling that of a baked apple, and it gave a strong reaction for acetaldehyde. The entire distillate was cohobated in a current of steam until the odourous constituents were contained in a volume of 0.5 litre. This concentrated liquid was completely extracted with ether, the ethereal liquid dried with anhydrous sodium sulphate, and the solvent removed as previously described. A pale yellowish oil was thus obtained, which amounted to 0.0614 g. or 0.000123 per cent. of the weight of material employed. It was evident from this result that the odourous constituents of the fruit are contained most largely in the outer portion or rind. This essential oil had a pleasant, apple-like odour and gave no reaction for furfural.

Hydrolysis of the Esters Contained in the Apple Distillate.

For the purpose of obtaining further information respecting the esters contained in the apple, and especially to ascertain whether geraniol could be detected in them, a considerable quantity (36.85 kg.) of apple parings was employed. The fresh material was brought into a still and, without any further addition of water, subjected to distillation in a current of steam. About 76 litres of distillate was collected, and this was subsequently cohobated with steam until the odourous constituents were contained in a volume of 1 litre. To this concentrated liquid, which was contained in a flask provided with a reflux condenser, 20 g. of pure sodium hydroxide was added, and the whole kept in a state of active ebullition for 2 hours. It had then acquired a deep yellow colour and become turbid, owing to the separation of aldehyde resin. After cooling, the alkaline mixture was distilled, and 0.5 litre of distillate collected. This liquid, which had a pleasant odour and contained some oily drops, was extracted 5 times successively with pure, aldehyde-free ether, the united ethereal liquids were dried with anhydrous sodium sulphate, and the greater part of the ether was removed by distillation. The residual liquid was then brought into a small pressure flask, in which it was allowed to evaporate spontaneously until all the ether had been removed. A yellowish oil was thus obtained, which amounted to 0.3641 g. and, therefore, represented 0.00098 per cent. of the weight of the apple parings employed. This oily liquid possessed a distinct odour of amyl alcohol, but the presence of a more fragrant substance was also indicated.

Oxidation of the Alcohols Obtained by Hydrolysis. Formation of Valeric Acid and Citral together with Acetone and Levulinic Acid.

To the small amount of the above-mentioned hydrolytic product contained in a pressure flask there was added, while being kept cool, 10 cc. of a chromic acid mixture[2] and, after closing the flask, the whole was heated on a water-bath at a temperature of about 90° for 15 minutes, with occasional agitation. After being allowed to cool, the mixture was diluted with water and extracted 5 times successively with freshly distilled, aldehyde-free ether. The united ethereal liquids were washed thrice with water, dried with anhydrous sodium sulphate, and the greater part of the ether was removed by distillation. The liquid was then transferred to a small distilling flask in which the remaining ether was allowed to evaporate spontaneously, the last portion of the solvent being removed by aspiration. A small amount of an oily liquid was thus

[2] *J. prakt. Chem.*, 1892, XLV., 599.

btained, to which some water was added, nd the product then distilled in a current f steam. Two fractions of distillate. mounting to 5 cc. and 25 cc. respectively, ere collected. The first portion was trongly acid, contained on the surface a mall globule of yellowish oil, and possessed distinctly lemon-like odour together with he odour of valeric acid.

Occurrence of Geraniol in the McIntosh pple.—A very small portion of the above-entioned acid distillate gave with Schiff's eagent a deep purplish colouration, similar o that yielded by citral and quite different om the colour produced by the ordinary liphatic aldehydes. It is also rapidly re-uced an ammoniacal solution of silver xide. These results, together with the dour of the original hydrolytic product, learly indicated the presence in the latter f a small amount of geraniol. Inasmuch s the further oxidation products of geraniol r citral are acetone and levulinic acid, the robable formation of small amounts of ese substances was also considered. About .5 cc. of the above-mentioned 5 cc. of dis-llate was consequently tested for acetone y means of the iodoform reaction; distinct ystals of the latter substance were btained.

In order to obtain evidence of the pre-nce of levulinic acid, the amount of which ould be extremely small, consideration as taken of its ketonic character and capa-ility of yielding iodoform. The following ethod was therefore employed for its de-ection. After the complete distillation of e oxidation product with steam, as above escribed, the liquid remaining in the dis-llation flask was extracted thrice with her, the united ethereal liquids were dried ith anhydrous sodium sulphate, and the eater portion of the ether was removed distillation, the residual liquid being lowed to evaporate spontaneously. A very ight amorphous residue was thus obtained hich was heated for a short time on a eam-bath in order to expel any trace of olatile substance. When cold it was eated with a little water, the filtered quid made slightly alkaline with sodium ydroxide and a few drops of iodine solu-on added, when a separation of iodoform on ensued.

The results of the above tests will be en to have given quite definite indications the formation of small amounts of both etone and levulinic acid, together with tral, by the oxidation of the above-described product of hydrolysis, and they are therefore believed to afford satisfactory evidence of the presence in the latter of geraniol.

Occurrence of Amyl Esters in the McIntosh Apple.—Although a previous investigation by the present authors[1] had established the fact that the odourous constituents of certain varieties of the apple consist chiefly of various amyl esters, their presence in the McIntosh apple has now also been determined. As already noted, the product obtained by the hydrolysis of the concentrated aqueous distillate possessed a distinct odour of amyl alcohol, and when subjected to oxidation by chromic acid, with subsequent extraction by ether and distillation of the ethereal extract in a current of steam, it yielded a strongly acid liquid containing some oily drops. It was also observed that the odour of this liquid indicated the presence of both citral and valeric acid.

In order to establish the identity of the last-mentioned substance, the first portion of the aqueous distillate, which had responded to the tests for both citral and acetone, was made alkaline with baryta, when the oily drops almost completely disappeared and the lemon-like odour of the liquid became much more pronounced. The two portions of distillate were then united, and the alkaline liquid was extracted thrice with pure ether. The ethereal liquids, after being washed with a little water and dried with anhydrous sodium sulphate, were allowed to evaporate spontaneously, when a slight residue was obtained which possessed a distinct lemon-like odour. When this residue was shaken with sensitized Schiff's reagent it soon developed the characteristic purple colour produced by citral.

After extraction with ether, as above described, the alkaline liquid was concentrated, filtered, the excess of baryta removed by carbon dioxide, and the liquid, which was now perfectly neutral, again filtered and concentrated. On the addition of silver nitrate it yielded a small amount of a white, curdy precipitate, which was collected, dried, and analysed.

Analysis. Subs., 0.0685: Ag, 0.0348. Calc. for Ag, $C_5H_9O_2$: Ag, 51.7. Found: 50.8.

A trace of the silver salt, when moistened with dil. sulphuric acid, developed a distinct odour of valeric acid. These results

may, therefore, be considered to confirm the presence of amyl esters in the particular variety of apple now examined.

Although the present investigation of McIntosh apples was conducted primarily for the purpose of determining the presence of geraniol, consideration was also given to all the constituents that had previously been found in other varieties of the fruit. The methods adopted for the separation and identification of these constituents, with the exception of the oxidation products of the alcohols, were practically the same as those previously employed, and therefore require no further description. The results, with the following slight exception, were in complete accordance with those previously obtained. A very small amount (0.06 g.) of a paraffin hydrocarbon, which separated from the original distillate of the apple parings, was obtained in the form of minute, acicular crystals, melting quite sharply at 54°. It differed in appearance from the analogous substance previously obtained from the Ben Davis apple, which melted at 63°.

CONCLUSIONS.

An examination of McIntosh apples, which represent a particularly fragrant variety of the fruit, has confirmed the results of a previous investigation that the odourous constituents of the apple consist chiefly of amyl esters, and it has also afforded further information respecting the substance which imparts to some apples a *distinctly rose-like odour*. Although the proportion of this substance, even in the McIntosh apple, is extremely small, it has nevertheless been possible to determine with a considerable degree of certainty that it consists of the aliphatic terpene alcohol geraniol $C_{10}H_{18}O$. The evidence for this conclusion may be adduced from the fact that by the hydrolysis of the esters of the apple a product was obtained which possessed, in addition to the odour of amyl alcohol, a rose-like fragrance, and that by the oxidation of this product it yielded, besides valeric acid, a substance which had the characteristic odour and other properties of the aldehyde citral. At the same time the formation in very small amounts of the further oxidation products of geraniol or citral, which are acetone and levulinic acid, was decisively indicated. It is probable that geraniol, either in the free state or in the form of esters, is contained in varying amounts in all the numerous vairetie of the apple, although to the greatest extent in those which possess its distinctive odour.

Washington, D.C.

New Patents.

THIS list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

34891—Etablissements Pouleno Freres.—Manufacture of hydroxylated aliphatic arsenic acids. Dec. 21.

34846—Madel, G.—*Roasting or calcining ores.* Dec. 21.

34479—Parrish, P.—Distillation of ammoniacal liquors. Dec. 18.

Specifications Published this Week.

189475—*Helps, G.—Manufacture of gas.*

189542—Ironside, T. G.—Process of distilling oil shales, coal, and other carbonaceous materials, and apparatus thereof.

189700—Dutt, E. E.—Process for the extraction of titanium dioxide and vanadium salts from bauxite.

189701—Willis, N. E.—Clarifying of solvents and oils.

184153—Chemische Fabrik Weissemstein Ges.—Manufacture of hydrogen peroxide.

187232—Chemische Fabrik in Billwarder Vorm Hell & Sthamer Akt Ges and Hasenclever.—Production of chrome-alum.

164731—Leibreich, Dr. E.—Process for separating out metallic chromium.

189834—Dandridge, A. G., and Thomas, J.—Manufacture of dyestuffs of the anthraquinone series.

168902—Norsk Hydro-Elektrisk Kvatlstof-Aktieslskab.—Production of ammonia from nitrogen and hydrogen.

181385—Jacobson, B. H.—Process of making anhydrous metallic chlorides.

Abstract Published this Week.

Synthetic Drugs.—Patent No. 188127.—Messrs. Casella & Co., Ges. L., of Frankfurt-on-Main, Germany, have Patented in this country a process for the preparation of Acridinium salts of fatty acids. The product is prepared by treating acridinium salts of mineral acids with salts of fatty acids of high molecular weight. Examples are given of the preparation of 3:6-diamino-10-methylacridinium stearate, 2:7-dimethyl-3:6-diamino-10-methylacridinium stearate, and 3:6-diamino-10-methylacridinium palmitate. The products are soluble in fats and oils and suitable for therapeutic use.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3276.

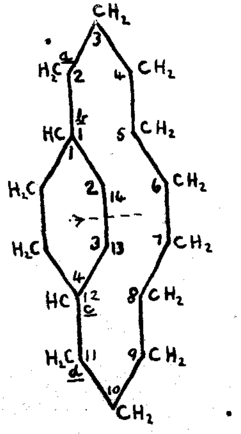
A NEW SYSTEM FOR THE LINEAR REPRESENTATION OF THE STRUCTURE OF ALL ORGANIC COMPOUNDS.

By T. Sherlock Wheeler, B.Sc., A.R.C.Sc.I., A.I.C.

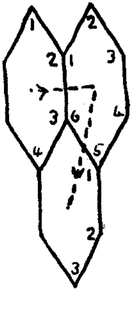
(*Continued from Page* 35.)

Bridges are shown as chains linked to a ring in two positions, just as two positions at which rings are fused are shown. X. is Al. VI. 2, 3 VI. 2, 5 III. (N–2, 2_3Me). It is to be noted that the numbering of the bridge is from the common carbon first given, in this case from "2." Bridged rings can also be considered as two ring systems fused in ortho, meta, para and other positions. The rules given for the ortho-hold for the meta- and para- fused rings, except that it is the extreme (tertiary) common carbons that are given in passing from one ring to another; the numbering of the second ring begins at the *extreme left-hand common carbon*. Some meta-fused rings are known: with the exception of bridged rings para-fused rings are *unknown to the present*. Compounds of the type of XI. do not seem impossible especially if the six membered ring shown be aromatic, as then the valencies "ab" and "cd" are fixed in a plane. XI. is Al. VI. 1. 4 XIV. The second ring in para-fused compounds can usually lie equally well on either side of the first. Adherence to the rule that the left-hand common carbon is given first is sufficient to show on which side of the first ring the second one lies. Al. VI. 4, 1 XIV. would be XI. with the second ring on the other side of the first. In the example given, these two compounds would be identical, but cases could occur where that would not be so. The same holds for rings fused in any position, but the question is not likely often to arise.

The same symbols preceded by Ar. and Al. always represent similar systems except in one case. That is when a ring has two adjacent sides common to two other rings. XII. is Ar. VI. 2, 3 VI. 5, 6 VI., and valency considerations show that the first and the third rings must be fused as shown. But the consistent interpretation of Al. VI. 2, 3 VI. 5, 6 VI. is XIII., and not XII.



XI

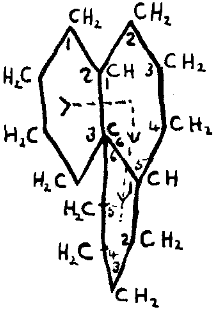


XII

fully reduced. To describe the latter, the third ring is considered as a chain joining the second and the first, and it becomes Al. VI.′ 2, 3 VI. 5, 4′ V̄. Any alicyclic compound can be dealt with in this way. It

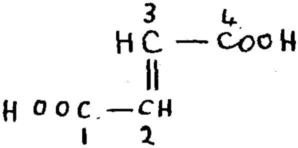
will be noted how the index identifies the ring to which we return.

Since aromatic rings are seldom written with the fourth bond, there is no need to indicate which method of disposing of it is being used. Should it be necessary to do this, a prefix "Cn" for the centric, or "K"



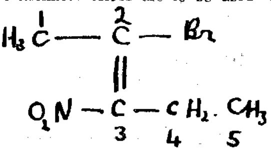
XIII

for Kekulé's method can be employed. If it be desired to have any conjugated bonds represented on Thiele's system, the prefix



XIV

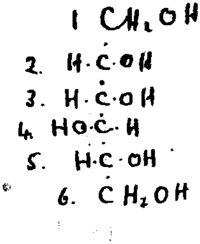
"Th" is placed before the ordinary symbol for them. "Cis," "trans," and such like stereo-chemical terms are to be used with



XV

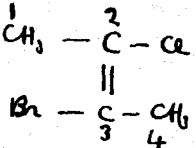
their present meanings. They are put in between the symbols of the groups or the elements to which they refer. XIV. is $\overline{\text{IV}}$. (1:4=(OH)$_2$, 1:4≡(O.)$_2$, Δ^2, 1 trans 4). XV. is $\overline{\text{V}}$. (2-Br trans 3-NO$_2$, Δ^2).

Fischer's "+" and "-" system is used



XVI

for the sugars and such like asymmetric compounds. XVI. is $\overline{\text{VI}}$. (2:3:5 ≡ $\overset{+}{(\text{OH})_3}$ 4-(OH), 1:6=(OH)$_2$), or VI. ($\overset{+}{1}$:$\overset{+}{2}$:$\overset{-}{3}$:$\overset{+}{4}$:5:6 ≡ (OH)$_6$). Cis and trans compounds can also be shown by the use of the same notation; XVII., *e.g.*, is $\overline{\text{IV}}$. ($\overset{+}{2}$-Cl, $\overset{-}{3}$-Br, Δ^2). Of course "+" and "-" then have not quite the same meaning in asymmetric and in stereo-chemical compounds, but the notation is convenient and no ambiguity is likely to arise. In compounds like the sugars, etc., the conventions as to the



XVII

graphical formula being written with the aldehyde group on top before the plus and minus rule is applied, etc., are adopted.

(To be Continued.)

THE RARE EARTHS AND THEIR METALS.

By John Missenden.

I.—The Composition of the Rare Earths.

(*a*) In view of the fact that so little has been known of the properties and reactions of many of the rare earth metals (and, accepting the periodic system for the classification of the elements as mathematically authentic, there is little doubt that others have yet to be discovered), and that the results of the majority of chemists differ to a more or less marked degree, it is small wonder that considerable differences of opinion prevail. The difficulties have not lain so much in the metals themselves as in their sources. The complexity of the so-called rare earths—their very composition, in the majority of instances, comprising more separate elements in both mechanical and chemical association than any other class of earth—demands so much care and precision in analysis, that only the most up-to-date methods of investigation can be called into use for the production of satisfying and exhaustive data.

But the difficulties confronting modern researchers are not nearly so formidable as those faced by Klaproth, Berzelius, and Hisinger, Gadolin, Mosander, and a host of others. These chemists—whose investigations ran over a period from 1793 (or 1794) to the end of the nineteenth century—examining not only the actual earths themselves, but also (as, specifically, in the case of Mendeléeff, who will be dealt with later) daring to predict the presence of undiscovered elements, started upon a train of research which was, perhaps, one of the most difficult branches of chemistry. Certainly, it was (and still is) the most interesting of all the metal groups.

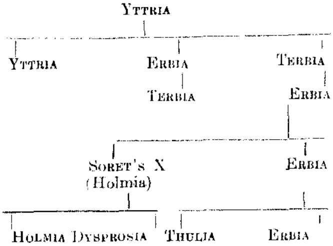
(*b*) Because the first of these mineral earths was discovered, according to the records dealing with that period, in Sweden, much of the credit for finding them is due to the professors and others studying in that country. Some idea of the arduity of their task can be gained by noting the dates which mark the intervals of bringing to light even the actual earths themselves, disregarding for a moment the separation of the metals. For instance, six years elapsed—six years of strenuous work—between the discovery of *gadolinite* (1788), and *yttria* (1794), which formed part of its composition. *Ceria* (1803) was not split up until thirty-six years had elapsed; while *didymia* (1841) resisted analytical efforts for thirty-eight years.

(c) *Gadolinite*, then, discovered by Professor Gadolin, who came from Abo, the one-time capital of Finland, formed the basis of subsequent experiments. Referring to the works of Petersson, which are dated more than a century later, it is found that this mineral earth consists of, among other compounds: yttrium oxide, Y_2O_3, 45.3 per cent.; cerium sesqui oxide, Ce_2O_3, 3.84 per cent. (?); didymium trioxide, Di_2O_3, and lanthanum oxide, La_2O_3, jointly 2.57 per cent.; and a profusion of the simple oxides of the commoner elements, such as iron, manganese, and silicon. So gadolinite has come to be regarded as one of the main sources of yttria, which, in its turn, yields the corresponding metal.

Following Gadolin's separation of yttria from gadolinite in 1788, Mosander further separated the earth into three parts, producing the *yttria* (as it is generally accepted to-day), *erbia*, and *terbia*. This was in 1843. Here, it seems, he abandoned his investigation, for in 1860, Berlin re-named terbia as erbia. In 1878, Delafontaine renamed the former erbia as terbia, and declared it to be incapable of further separation. Soret, in the same year, more closely investigated the newly appellated erbia, with the result that he separated an unknown earth (Soret's X).

Even now, these earths were not in their more elementary form. Erbia was further examined by Cleve (1879), and another earth, *thulia*, discovered; but this discovery settled finally the complete separation of this particular compound.

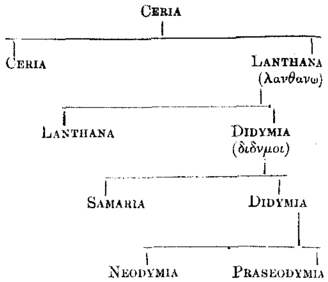
Soret's X was also studied by Cleve in the same year, and he re-named it *holmia*, although it was left to Lecoq de Boisboudran to produce yet another base, which he called *dysprosia*. In order to show the extreme complexity of the original yttria, the following table is appended:—



ogy is found a detailed tabulated analysis of cerite compiled from the results of Lindström (1873). The figures tally, to a certain extent, with those obtained from the recently mined specimen; but Lindström fell short of his 100 parts by 0.48 per cent. As, however, he only shows 3.44 per cent. of water, the probability is that he lost the remaining negligible percentage by evaporation. The recent specimen shows a considerable increase in water; that is to say, 5.68 per cent.

In the reduction of this earth, insoluble oxalates of the metals are precipitated from the salts in solution. Because all the earths differ from each other to such a small extent, discrimination between them, save by processes of separation and chemical peculiarities, is impossible. This branch of the subject will be dealt with later.

(*d*) The next of these mineral earths to be discovered was cerite. This was due to Klaproth (1803), who found it at Riddarhyttan. Subsequent examination by two other chemists was responsible for the opinion—astonishingly erroneous—that this cerite was the oxide of the new elementary metal which they christened *cerium*. Mosander, however, in 1839, proved that such was not the case, and produced another mineral which he called *lanthana*. As in the case of yttria, so in the case of ceria. This new lanthana comprised *didymia*, from which *samaria* (Boisbaudran), *neodymia* and *praseodymia* (Aver von Welsbach) were obtained. Thus a second table may be evolved, as follows:—



A specimen of cerite, mined at Lövön, bore some similarity to Petersson's gadolinite, which was mined at Ytterby. It contained, among other compounds, 26.87 per cent. of cerium sesquioxide, C_2O_3; 18.22 per cent. of didymium trioxide; and 15.95 per cent. of lanthanum oxide, La_2O_3; the bulk of the remaining 100 parts being composed mostly of silicia. In Dana's *Mineral-*

(*e*) *Fergusonite*, described as a niobate of erbium, cerium and yttrium, was examined by Rammelsberg. He selected a specimen from the Godthaab region in Greenland, and found that it contained 24.87 per cent. of yttrium oxide, 9.81 per cent. of erbium oxide, 2 per cent. of cerium sesquioxide, 44.55 per cent of niobium pentoxide, 5.63 pe rcent. of lanthanum oxide, and 6.3 per cent. of tantalum pentoxide. In his examination, however, he fell short of the 100 parts by 0.9. There is no evidence to hand to show the cause of this deficiency, but the belief is justified that he also lost a considerable amount of water by evaporation.

A specimen obtained from Chattanooga, in Tennessee, differs widely from Rammelsberg's specimen. Here, only 20.08 per cent. of yttrium oxide was present, with a corresponding decrease in the quantities of the other oxides, and an increase in iron monoxide. Tables embodying the later analyses will be reproduced at the conclusion of this section.

(*f*) *Samarskite*. This earth, perhaps, contains a more varied assortment of the rare earth metals than any other. It is regarded as the main source of didymia, from which the pure didymium is obtained. In 1877, Allen succeeded in analysing it with a remarkable degree of accuracy; while

Welsbach (1884-5), studying it even more closely, produced the two metals, neodymium and praseodymium. This has been already dealt with in brief, the original ceria being quoted as the primary source. Samarskite, also, contains considerable quantities of uranium and tantalum; so much, indeed, that Roscoe refers to it as "Urano-tantalate." At the same time, it is by no means the chief source of uranium, pitcheblende containing the impure uranouranic oxide, U_3O_8, to tht extent of 75 per cent. approximately.

According to Allen, who obtained his specimens from the mountainous west of N. Carolina, cerium sesquioxide, didymium trioxide and lanthanum oxide are jointly present to the extent of 4.17 per cent.; while of uranium trioxide there is 12.45 per cent., and of tantalum pentoxide there is 18.2 per cent. A later specimen from the same district more or less confirms his figures. The earth is described as a tantalate and niobate of yttrium, erbium, cerium, uranium and iron.

(*g*) *Euxenite* has been investigated by Nilson in 1879 (*Ber. Deut. Chem. Ges.*, 1879, XII., 554), from which he obtained the oxide of scandium. Referring again to the analyses of Rammelsberg, it is composed mainly of yttrium oxide, erbium oxide, cerium sesquioxide, and the higher oxides of niobium and tin. Uranium is also present. Although Rammelsberg made a very careful separation, extending his study with great care, he failed to obtain accurate results, finally obtaining 101.59 parts. This considerable error is probably due to his estimation of niobium, the figure for which is 35.83 per cent. Proportions which will be far more acceptable are: yttrium oxide, 18.02; erbium oxide, 9.85; cerium sesquioxide, 2.38; niobium pentoxide, 32.21; stannic oxide, 25.97.

(*h*) *Thorite*, save for its 58.91 per cent. of thorium oxide, and its scanty complement of uranium trioxide (1.72 per cent.) is barely worth mention. *Yttrocerite*, which is the main source of cerium fluoride and yttrium fluorite, is found in numerous places, but a detailed analysis is not yet to hand; it will be dealt with more fully at a later date. *Monazite*, which was discovered by Karsten while he was investigating the properties and source of thorium, is described as a phosphate of lanthanum and cerium. Karsten gives the figures: lanthanum oxide, 23.4 per cent.; and cerium sesquioxide, 26 per cent. *Yttrotantalite* is composed of 27.69 per cent. of yttrium oxide, 12.44 per cent. of erbium oxide, 1.9 per cent. of cerium sesquioxide, 42.12 per cent. of niobium pentoxide, and 0.22 per cent. of tungsten trioxide (Rammelsberg). *Orangeite*, investigated by Bergman, contains 74.26 per cent. of thorium dioxide. *Columbite*, investigated by Blomstrand in 1865 (*Journ. Prakt. Chem.*, 1866, XCVII., 37), varies greatly according to its locality. Whereas n Massachusetts it contains 28.55 per cent. of tantalum pentoxide and no traces of lead, the specimen obtained from Godthaab contained no tantalum whatsoever, the oxide being replaced by a considerable increase in the amount of niobium pentoxide, while the amount of lead monoxide extant is 0.12 per cent. *Tantalite* is composed, in the main, of 76.34 per cent. of tantalum pentoxide, 13.9 per cent. of iron monoxide, and 7.54 per cent. of niobium pentoxide. *Pyrochlor* contains 10.98 per cent. of titanium dioxide, 7 per cent. of cerium sesquioxide, 7.56 per cent. of thorium dioxide, and 50.11 per cent. of niobium pentoxide. Both of these last earths were investigated by Rammelsberg.

There is also an extensive list of other earths, as, for instance, *orthite*, *acanthite*, and *daleminzite*. These do not, however, yield sufficient quantities of the metals to be regarded as important. In every case, they come within the sphere of other metals, such as silver, aluminium, etc.

A few little-known rare earths are believed to exist as separate from those already mentioned. *Lanthanite* contains cerous carbonate; *decipite* is a component of some forms of samarskite; and *lanthanotantalite* is a complex earth undiscovered until the end of 1921. These are typical examples.

(*i*) The accompanying table, compiled from accepted authorities, has had personal results added. The uppermost quotations are the results obtained by the chemist whose name appears at the head of the column. It would perhaps be as well to mention that the table is by no means complete, numerous unimportant oxides being omittd. It does, however, embody everything having significant bearing upon the subject in hand.

(*j*) Two earths have been described by various chemists as *mosandrio-* and *philippia*, but both of these have been resolved into other earths, being mechanical mixtures of the same. (*Roscoe and Schorlemmer*; II., 622).

TABLE SHOWING THE CHIEF COMPONENTS OF THE RARE EARTHS

Oxides.	Gadolinite (Paterson)	Cerite (From Dana)	Yttro-tantalite (Rammelsberg)	Samarskite (Allen)	Euxenite (Rammelsberg)	Monazite (Karsten)	Fergusonite (Rammelsberg)	Tantalite (Rammelsberg)	Thorite (Berzelius)
Y_2O_3	45.3. 48.19.	— —	27.69. —	14.48. 12.97.	17.23. 18.02.	— —	24.87. 20.08.	— —	— —
e_2O_3	3.84? 1.07	24.06 26.87.	1.9 —	4.17# 2.05.	2.34. 2.38.	26.0 —	2.0 1.67	— —	— —
i_2O_3	2.57 ※ 2.3	35.37. 18.22.	— —	0.08	— —	— —	— —	— —	— —
a_2O_3	0.08.	15.95.	— —	2.61	— —	23.4 —	5.63 5.0	— —	— —
r_2O_3	— —	— —	12.44 —	— —	9.39 —	— —	9.81 —	— —	— —
ThO_2	0.41 0.12	— —	— —	— —	— —	17.95 —	— —	— —	58.91 56.32
a_2O_5	— —	— —	10.05 —	18.2 18.22	— —	— —	6.3 4.93	76.34 —	— —
TiO_2	— —	— —	— —	— —	— —	— —	— —	— —	— —
UO_2	— —	— —	1.26 —	— —	8.86 9.31.	— —	2.58 2.82	— —	— —
UO_3	— —	— —	— —	12.54 11.31.	— —	— —	— —	— —	1.64 0.95
WO_3	— —	— —	0.22 —	0.08 * 0.13 *	— —	— —	0.15 0.25	— —	— —
FeO	12.89 11.25	3.92 2.03	0.63 —	10.75 12.6	3.61 3.09	— —	0.74 4.66	13.9 —	— —
e_2O_3	0.6 0.94	— 2.71	— —	— —	— —	— —	— —	— —	3.46 6.88
CaO	0.54 1.2	4.35 4.3	2.31 —	0.55 0.48	— —	1.68 —	0.61 0.58	— —	— —
ZrO_2	— —	— —	— —	— 0.1	— —	— —	— 0.03	— —	— —
b_2O_5	— —	— —	42.12 —	37.5 38.61	35.83? 32.21	— —	44.45 40.35	7.54 —	— —
Lead	— 0.13	— —	— —	— —	— —	— —	— —	— —	0.82 1.3
Tin	— —	— —	0.24 —	— —	24.33 25.97	2.1 —	0.47 —	0.7 —	0.01 —
of ...minium	— —	1.26 0.88	— —	— —	— —	— —	— —	— —	0.06 0.09.
of	—	—	—	—	—	—	—	—	0.15

A considerable number of the more elementary earths have been formulated. *Keilhauite*, for instance, has been symbolised thus: Ca Y (Ti Al Fe) SiO_5. A vanadium-bearing earth, *vanadinite* (also described as lead vandate, in spite of the presence of a chloride) has the formula: $3Pb_3 (VO_4)_2 + PbCl_2$, also $Pb_3 (VO_4)_2 + Pb_2 (VO_4) Cl$. For most practical purposes of expression, the method is sound enough, as it denotes the main components of the earths. It does not admit the embodiment of their natural composition, however, consequently is far from accurate. It is also cumbersome. Let the composition of samarskite be considered as a case in point. This is determined to be a nioba-tantalate of thirteen rare earth metals, calcium, uranium and iron. To express this as a formula would be absurd, and its very complexity, by virtue of the number of symbols, would tend to confound.

APPARATUS FOR THE RECOVERY OF BROMINE FROM SODIUM HYPOBROMITE.

BY C. H. COLLINGS.

I.—THE APPARATUS.

In *The Chemical News* for December 1, 1916, I described a simple apparatus to recover bromine from sodium hypobromite, whether new or stale, used or not, and to at once recombine it with NaHO as fresh hypobromite. The method was simple: to mix slowly the waste hypobromite with a mineral acid, thus gradually disengaging the Br, simultaneously aspirating the latter as a vapour into fresh NaHO. In its first form, the apparatus suffered from one marked defect, however, and that was the considerable residuum of Br left in the mixed acid and waste. A fair amount of experimenting was needed to overcome this; but the improved form now illustrated has been in use for a considerable time with consistently satisfactory results, and I would call the attention of all considerable users of sodium hypobromite to it as a simple, compact, effective and rapid means of recovering Br from waste that otherwise goes down the sink, to the distinct disadvantage of their pockets. The new form does not require skilled attention, and practically speaking, runs itself; further, no Br vapour can escape into the air of the room. By its use one can even avoid altogether the need to handle and store Br as such, as by obtaining the hypobromite ready-made one can readily recover from it needed Br (to recombine as NaBrO) as convenient. This creates a great advantage, by eliminating the cost, delay and trouble attending the transit of a dangerous chemical like Br; further, where admission of Br into one's geographical area happens to be inhibited, the hypobromite may be imported and regarded, from the point of view of the apparatus, as a convenient storehouse of Br.

On reference to the illustration (kindly lent by Messrs. Baird and Tatlock, who are putting the apparatus on the market), it will be seen that the operations needed are few and simple. The whole thing is connected up first with an aspirator or pump at (P). Caustic soda solution of the usual hypobromite formula is introduced into (HJ) *via* the calibrated cup (H). Acid (HNO_3) is poured into (A) up to the mark, then run into the mixing-chamber (MC), and the acid tap turned off. Waste hypobromite from which the Br is to be extracted is poured into (W) up to the mark, the aspirator started, the tap of (W) timed to allow a drip of 60 or fewer drops to the minute—and the affair may be left to run itself with, perhaps, one subsequent readjustment, if necessary, of the dripping tap. The stream of aspired air passing through the reacting substances from bottom to top, carries practically the whole of the Br, by degrees, into the waiting NaHO and so forms new hypobromite. The valve (V) is nearly filled with NaHO solution (not water), and both physically and chemically inhibits any back pressure of Br into the air of the room. The whole process takes about 20 minutes. The mixed acid and exhausted waste are then emptied (by turning the tap at bottom of mixing-chamber) into (RJ) below.

II.—ON CERTAIN EXPERIMENTS WITH THE APPARATUS.

Having established the successful working of the apparatus, and observed that (as mgiht be expected) a slight residuum of unrecoverable Br remained behind, in solution, in the mixing-chamber, the next step was to ascertain the allowance to be made for this in fixing the quantity of waste sodium hypobromite from which 2.2 cc. of Br could be actually recovered to recombine with fresh NaHO solution in the hypobromite jar. The simplest way was to exhaust the urea-decomposing power of ordinary hypobromite, made according to

the usual formula (25 cc. NaHO + 2.2 cc. Br), recover the Br from this, similarly exhaust the recovered Br hypobromite, and compare the total N percentages in each case (expressed as urea): thus obtaining the ratio by which the extra quantity of waste sodium hypobromite to anticipate Br loss in the mixing-chamber could be directly calculated. This necessary experiment led to a quite unexpected result.

The total urea percentage obtained by exhausting ordinary hypobromite was found to range around 9.5. Such exhausted hypobromite then yielded up its Br *via* the apparatus into a new lot of NaHO, and the corresponding figure of *this*, so far from being less than 9.5, was found (in each of several experiments) to range round 11.3 per cent.! Again, such an exhausted hypobromite was instead kept for a week, its Br recovered, recombined as hypobromite, and duly exhausted. It gave a total of 11.8 per cent. of urea.

It is a familiar fact that sodium hypobromite has to be newly made for urea estimation, as it soon deteriorates as regards this function. I have found the rate of deterioration to be about 10 per cent. per day, the percentage not being calculated on the initial value, after the first day, but on the residual value of each day. Now the singular thing is that, as far as my experimenting has gone, hypobromite that has been kept a week in its original unused condition (and whose urea value in the first instance would be about 9.5) on being passed through the apparatus yielded Br that, combined with the usual 25 cc. NaHO, produced a hypobromite of total urea value of 13.3 per cent. Further, hypobromite made in the usual way, and similarly treated without waiting a week, produced hypobromite of total urea value of 13.0 per cent.

The practical consequence of these figures is that an amount of waste equal to the contents of the original hypobromite bottle is quite adequate to yielding a sufficiency of Br, which, recombined under the conditions ruling in the apparatus, more than balances the trifling loss of Br in the mixing-chamber. This holds good whether the original hypobromite be newly made and used or not, or has stood a week unused, or has been used new and is now stale, or used when stale, and is either partially or wholly exhausted.

The above facts and figures suggest more than one problem of varying interest. Two of them might be briefly considered:

(1) The total urea-decomposition capacity of recovered Br, when recombined with NaHO, is, in the first recovery, greater than that of the hypobromite from which it has been recovered.

(2) Such increase is greatest in the case of unused hypobromite, new or even ten days old.

Regarding (1)—

When urea is "acted upon" by sodium hypobromite, the following ensues:—

$$CO(NH_2)_2+3\,NaBrO = N_2+CO_2+2H_2O+3\,NaBr.$$

This reaction may be the outcome of simple chemical affinity (as is implied by the expression "acted upon") between the urea and the NaBrO: although as no combination of any kind between the urea or any of its constituents is formed with NaBrO or NaBr, chemical affinity would seem hardly a happy term. Further, as NaBrO spontaneously breaks down into NaBr and O, it can hardly be called reduction. Alternatively, in view of the fact that from its first formation NaBrO steadily breaks down into NaBr and O, it may be that urea exerts a catalytic action on it, accelerating its transformation from NaBrO to NaBr. The rapid disengagement of O atoms at once ensuing would react upon the urea, to each molecule of which three atoms of O, as per the equation, would be attracted, leading to its breaking down into free N, CO_2 and H_2O. This explanation seems, on the face of it, to be as good as the other, and for this reason the catalytic hypothesis, if not already entertained, might be considered.

We are now, however, concerned with the composition of the mixture usually, in urine analysis, referred to as sodium hypobromite. The nature of this demands close scrutiny if we are to cope with the two points just raised, and explain in a rational manner the associated percentage figures. The usual equation is:—

$$Br_2 + 2NaHO = NaBr + NaBrO + H_2O.$$

Here the ratio of Br-O to total Br is as 2 to 4.

It will be borne in mind, of course, that the NaBrO at once, slowly and steadily spontaneously parts with its oxygen and becomes the stable but useless form, NaBr. Hence sodium hypobromite does not "keep."

Now, to explain the increased power of the hypobromite solution, as furnished by

the apparatus, we must keep in mind at least three points: that the urea breaks down in response to the action of oxygen atoms qualified by their intimate association with Br atoms up to the last moment; that, consequently, oxygen linked with Br must be present to the maximum extent; that sources of oxygen other than those available under ordinary circumstances, be demonstrated. The Br is, for practical purposes, a constant factor.

In the case of sodium "hypobromite" made in the usual way for urine analysis, there is practically always a slight white precipitate. This is evidently $NaBrO_3$, formed as a consequence of the heat evolved, and represents so much unavailable oxygen (+ Br, in solid form) for the purposes of urea decomposition. The usual solution, then, starts handicapper. In hypobromite made in the apparatus there is no such precipitate, doubtless owing to the cooling effect of the rapidly passing air bubbles through the forming hypobromtie—which latter, again, forms relatively slowly, thus keeping down the temperature and avoiding the precipitation of $NaBrO_3$: hence, in the apparatus-formed hypobromite, a trifle extra NaBrO is derived from this circumstance.

During the mixing process between the acid and the waste sodium hypobromite, with the evolution of free Br, passes from the bottom of the chamber up through the mixed acid and waste, tht purpose of which is to disengage from the mixture the Br freed by the acid, and to carry it, together with that in the air of the mixing-chamber, in vapour form to the bottle in which NaHO awaits it to form therewith fresh hypobromite. It seems possible that besides doing this, the air may contribute a little of its oxygen to the general atomic rearrangement going on, which, with easily available hydrogen would combine with a modicum of the Br into hypobromous acid. The latter, in aqueous solution, passes over in vapour form, to be decomposed in the NaHO bottle, and so forcibly contribute an extra atom of oxygen along with its atom of Br: the first stage of this process being perhaps reduction to hydrobromic acid (HBr) with free oxygen. Shortly—

$$Br_2+HBrO+3NaHO = NaBr+2NaBrO+2H_2O$$

(Ratio of BrO to total Br, 2 to 3).

White fumes of what almost certainly would be hydrobromic acid have been observed on different occasions at the top of the mixing-chamber and simultaneously in the delivery-tube, NaHO bottle and even rarely, as far as the aspirator itself.

So far the above two equations correspond roughly to the figures obtained with hypobromite made in the usual way (9.5 circa) and those from recovered exhausted hypobromite (11.5 circa) with ratios of O to Br as 2 to 4 and 2 to 3 respectively, i.e., an increase of urea-detonating oxygen in the latter case over the former. There still remain the figures (13.0 circa) obtained from hypobromite made from Br recovered from hypobromite, new or stale, that has remained unused. Now, as the $NaBrO$ steadily breaks down to NaBr and free O it seems reasonable to assume that such unused hypobromite contains spare oxygen either still in temporary combination with NaBr or but lately parted therefrom. This would go to enrich the oxygen content of the air stream, and would thus bring into contact with the nascent Br vapour an atmosphere especially full of oxygen: circumstances peculiarly favourable to the formation of fully oxidised Br compounds. Here, then, I would suggest an hypothesis not (I think) altogether unreasonable, and one moreover that assists to meet and explain the observed facts, viz., that a compound usually assumed not to exist may be formed under these unusual circumstances, to wit, sodium bromite ($NaBrO_2$) a compound which at the cost of merely the usual one, necessary, Br atom, would furnish double the reaction energy (O_2) in relation to its dissociating action upon the urea molecule.

Assuming this for the moment, and excluding *pro temp.* the hypothesis of HBrO being formed and carried over, let us write an equation corresponding to the possible facts: no more than one free oxygen molecule being added to represent the contribution of the rich atmosphere previously described:—

$$2Br_2+O_2+4\ NaHO = NaBr+2\ NaBrO+NaBrO_2+2H_2O$$

With a ratio of BrO to Br as 2 to 2.

I do not know if this view will be accepted; but this can at least be said for it, that it furnishes the necessary mechanism to account for the observed result, for the startling increase (approaching 40 per cent.) in the total urea decomposable by hypobromite made in this manner (in the apparatus) over that made in the usual way, Br and NaHO being as near as may be identical quantities in each case—the

Br, if anything, being a trifle less in the recovered quantity. Equally, has sodium hypobromite been put together in this manner by other experimenters, the Br largely as vapour with a copious admixture of, at least atmospheric oxygen? If not, it might be worth someone's while to do it, and see what may happen under these conditions.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

LIST OF PROBABLE PAPERS FOR READING, JANUARY 25, 1923.

PROF. A. V. HILL, F.R.S., *The Potential Difference occurring in a Donnan Equilibrium and the Theory of Colloidal Behaviour.*

E. F. ARMSTRONG, F.R.S., and T. P. HILDITCH, *A Study of Catalytic Actions at Solid Surfaces. X.—The Interaction of Carbon Monoxide and Hydrogen as conditioned by nickel at relatively low Temperatures. A Practical Synthesis of Methane.*

J. HOLKER, D.Sc., *The Periodic Opacity of certain Colloids in progressively increasing Concentrations of Electrolytes.* Communicated by Prof. A. V. Hill, F.R.S.

E. K. RIDEAL and R. G. W. NORRISH, *The Photochemistry of Potassium Permanganate. Part I.—The Application of the Potentiometer to the Study of Photochemical Change. Part II.—On the Energetics of the Photo-decomposition of Potassium Permanganate.* Communicated by Sir William Pope, F.R.S.

E. A. FISHER, *Some Moisture Relations of Colloids. I.—A Comparative Study of the Rates of Evaporation of Water from Wool, Sand and Clay.* Communicated by Prof. A. Smithells, F.R.S.

R. WHYTLAW-GRAY, J. B. SPEAKMAN, and J. H. P. CAMPBELL, *Smokes, A Study of their Behaviour and a Method of Determining the Number of Particles they contain.* Communicated by Prof. A. Smithells, F.R.S.

R. WHYTLAW-GRAY and J. B. SPEAKMAN, *A Method of determining the Size of the Particles in Smokes. Part II.* Communicated by Prof. A. Smithells, F.R.S.

R. C. DAY, *The Effect of long Grinding on Quartz (Silver Sand).* Communicated by Dr. M. W. Travers, F.R.S.

THURSDAY, JANUARY 18, 1923, AT 4.30 P.M.

Papers read:—

J. BARCROFT, F.R.S., *Observations on the Effect of High Altitude on the Physiological Processes of the Human Body.*

PROF. E. W. MACBRIDE, F.R.S., *Remarks on the Inheritance of Acquired Characters.* (Verbal communication only).

C. F. COOPER, *Baluchitherium osborni.* (? syn. *Indricotherium turgaicum.* Borrissyak). Communicated by Dr. A. S. Woodward, F.R.S.

J. A. GUNN and K. J. FRANKLIN, *The Sympathetic Innervation of the Vagina.* Communicated by Sir Charles Sherrington, P.R.S.

H. G. CANNON, *On the Metabolic Gradient of the Frog's Egg.* Communicated by Prof. E. W. MacBride, F.R.S.

BASISWAR SEN, *On the Relation between Permeability Variation and Plant Movements.* Communicated by Sir William Bayliss, F.R.S.

H. L. DUKE, M.D., *An Enquiry into an Outbreak of Human Trypanosomiasis in a "Glossina morsitans" Belt to the East of Mwanza, Tanganyika Territory.* Communicated by Mr. C. Dobell, F.R.S.

LOUIS DOLLO, Sc.D., *Le Centenaire des Iguanodons* (1822-1922). Communicated by Prof. A. C. Seward, F.R.S.

MINERALOGICAL SOCIETY.

JANUARY 9.

Dr. A. E. H. Tutton, Past-President, in the chair.

A. BRAMMALL and H. F. HARWOOD, *Dartmoor occurrences of (1) rutile, brooyite and anatase, (2) zircon.*

(1) Anatase, with less abundant brookite and scanty rutile, is common in Dartmoor stream-sands, etc. Anatase and brookite, absent from the unaltered grey granite, have been found in pneumatolysed rocks, especially "red" granites, and the mode of genesis of these two minerals is discussed. Data provided by chemical work on "baueritised" Dartmoor biotite (containing about 1.8 per cent. TiO_2) and by the occurrence of anatase granules encrusting detrital grains of ilmenite are examined in their bearing on the possibility that some anatase may have developed (or existing crystals may have continued to grow) in detrital material after sedimenta-

(2) Two strongly contrasted kinds of zircon crystals are described: differences in crystal habit, nature of inclusions, and mode of occurrence in the granite suggest that the dominant kind, which is tawny, zoned, and rich in inclusions, crystallised out from the magma early, and that the subordinate kind, water-clear and containing few inclusions ,separated out at a much later stage.

DR. L. J. SPERCER, with chemical analyses by E. D. MOUNTAIN, and microscopical determinations of the pseudomorphs by W. CAMPBELL SMITH, *A davyne-like mineral and its pseudomorphs from St. John's Island, Egypt.*

Two small crystals found with peridot, garnierite, etc., showed the physical characters of davyne, but consist of a complex silicate (with sulphate and carbonate) of aluminium, calcium, magnesium, and sodium, together with a considerable amount of water. Pseudomorphs after this material are more abundant: they consist of a complex of hydrated silicates of aluminium and magnesium, together with small amounts of corundu and spinel.

UNIVERSITY OF LONDON, KING'S COLLEGE, AND KING'S COLLEGE FOR WOMEN.

PUBLIC LECTURES AND ARRANGEMENTS IN THE LENT TERM, 1923.

Admission to public lectures is free and without ticket unless otherwise stated. When cards of admission are required, they can be obtained on application to the Registarr, to whom all enquiries with regard to public lectures should be made in the first instance. A stamped addressed envelope should be enclosed.

FACULTY OF NATURAL SCIENCE.

A Course of Eight Public Lectures, on Wednesdays, at 5.30 p.m.

"SOME ASPECTS OF NATURAL PHILOSOPHY."

January 24: "The Quest of Science Today, and as exemplified in its History," by Professor A. N. Whitehead, F.R.S., M.A., Sc.D. (Camb.), LL.D. (St. Andrews), D.Sc. (Manchester).

January 31: "The Measurement of Steller Distances,' by The Astronomer Royal.

February 7: "The Fundamental Conceptions of Biology," by Dr. J. S. Haldane, F.R.S., M.A., M.D., LL.D. (Edin.), M.A. (Oxford), LL.D. (Birmingham).

February 14: "The Succession of Floras in the Past," by Dr. Dukinfield Scott, F.R.S., M.A., LL.D., D.Sc.

February 21: "A Physico-Chemical Theory of the Instability of Western Civilisation," by Professor F. Soddy, F.R.S., M.A.

February 28: "The Limitations of Natural Science," by Principal L. P. Jacks, C.A. (Lond.), Hon. M.A. (Oxford), Hon. LL.D. (Glasgow), Hon. D.Litt. (Liverpool), Hon. D.D. (Harvard).

March 7: "Some Thoughts on the Relations of Science and Industry," by Sir Herbert Jackson, K.B.E., F.R.S., A.R.C.M., F.I.C., F.C.S., Director of Research, British Scientific Instruments Research Association; Emeritus Professor of Chemistry, University of London.

March 14: "The Influence of Science," by Sir Richard A. Gregory, D.Sc. (Leeds), F.R.A.S., F.Inst.P., F.J.I.

DEPARTMENT OF CLASSICS AND HISTORY.

An inaugural lecture will be delivered on Friday, January 19, at 5.30 p.m.,

"PROLEGOMENA TO THE STUDY OF ANCIENT GREECE,"

by Edwyn Bevan, M.A., LL.D., Lecturer in Hellenistic Language and Literature.

FACULTY OF THEOLOGY.

A Course of Three Public Lectures (arranged by the University), at 5 p.m., on March 8, March 13, and March 15.

"ETHICS AND THE PHILOSOPHY OF HISTORY,"

by Professor Ernst Troeltsch, of the University of Berlin.

A Course of Ten Public Lectures, on Tuesdays, at 5.30 p.m., illustrated by Lantern Slides.

"SIXTEENTH-CENTURY ART."

Commencing January 23.

Tickets for these lectures can be obtained before each lecture outside the Great Hall, or between 10 and 4 at the College Office. Fee: 1s. for one lecture, 7s. 6d. for the course of ten. By the Rev. Percy Dearmer, D.D., Professor of Ecclesiastical Art.

A Course of Six Public Lectures and Practices, on Mondays, at 5.30 p.m.

"ECCLESIASTICAL MUSIC."

Commencing February 5.

This course is arranged by the Rev. C. F Rogers, M.A., Professor of Pastoral Theology.

DEPARTMENT OF HISTORY.

A Course of Six Public Lectures (arranged by the University), on Thursdays, at 5.30 p.m., beginning January 18.

"THE NOMADS OF CENTRAL ASIA."

By Professor V. Barthold, Professor of the University of Petrograd.

DEPARTMENT OF PHILOSOPHY.

A Course of Six Public Lectures, on Tuesdays, at 5.30 p.m., commencing February 20.

"PHYSICAL CASUALITY AND MODERN SCIENCE."

By H. Wildon Carr, D.Litt., Professor of Philosophy.

A Course of Four Public Lectures on Tuesdays, at 5.30 p.m., commencing January 23.

"THE ENIGMA OF SOCRATES."

By Miss Hilda D. Oakeley, M.A., Reader in Philosophy.

A Course of Three Public Lectures on Fridays, at 5.30 p.m., commencing March 2.

"THE CASE FOR PLURALISM."

By C. E. M. Joad, M.A.

DEPARTMENT OF PSYCHOLOGY.

A Course of Three Public Lectures on Mondays, at 5.30 p.m., commencing February 19.

"PSYCHOLOGY AND PSYCHOTHERAPY."

By William Brown, M.A., M.D., D.Sc., M.R.C.P., Wilde Reader in Mental Philosophy in the University of Oxford, and Honorary Consulting Psychologist, Bethlem Royal Hospital, etc.

SCHOOL OF SLAVONIC STUDIES.

The following lectures will be delivered in Room 14D, unless otherwise stated:

A Course of Eight Public Lectures on "POLAND."

On Mondays, at 5.30 p.m., commencing January 22.

By Professor Roman Dyboski (Professor of English Literature in the University of Cracow).

A Public Lecture, on Monday, February 5, at 5.30 p.m.

"THE ORIGINAL HOME OF THE SLAVS."

By N. B. Jopson, M.A., Reader in Comparative Slavonic Philology.

A Course of Nine Public Lectures, on Tuesdays, at 5.30 p.m., commencing January 23.

"CONTEMPORARY RUSSIA FROM 1861."

By Sir Bernard Pares, K.B.E., Professor of Russian

A Course of Three Public Lectures, on Thursdays, at 5.30 p.m., beginning January 25.

"MODERN CZECH NOVELISTS."

By Otakar Vocadlo, Doctor of the University of Prague; Lecturer in Czecho-Slovak.

Two Public Lectures, on Thursdays, at 5.30 p.m.

February 15: "Slowacki and the King Spirit."

February 22: "Some Poetry of Mickiewicz."

By Leonard Wharton, M.A., Lecturer in Polish Literature.

A Public Lecture, on Thursday, March 1, at 5.30 p.m.

"POST-WAR POETRY IN POLAND."

By F. Sobienowski.

Three Public Lectures, on Thursdays, March 8, 15, and 22, at 5.30 p.m.

"THREE RUSSIAN POETS, PUSHKIN, LESKOV, AND BLOK."

By Prince D. S. Mirsky, Lecturer in Russian Literature.

A Course of Ten Public Lectures, on Fridays, at 5.30 p.m., commencing January 19.

"SERBIA AND THE JUGO-SLAV MOVEMENT."

By R. W. Seton-Watson, D.Litt., Professor of East European History.

SCHOOL OF SPANISH STUDIES.

A Course of Three Public Lectures, on Thursdays, February 22, March 1, and March 8, at 5.30 p.m.

"THE PRESENT CONDITIONS, HISTORIC ORIGINS AND RECENT REFORMS OF SPANISH EDUCATION."

By Senor Don José Castillejo, Professor in the University of Madrid and Secretary to the Junta para Ampliacion de Estudios.

H.E. The Spanish Ambassador will take the chair at the first lecture.

Those particularly interested in this course should enquire from the Registrar (enclosing a stamped addressed envelope).

Two Public Lectures, on Thursday, March 15, and Thursday, March 22, at 5.30 p.m.

"THE TENDENCIES OF THE SPANISH DRAMA SINCE 1868."

By Walter Fitzwilliam Starkie, M.A., Trinity College, Dublin.

DEPARTMENT OF MODERN GREEK

A Course of Six Public Lectures, on Tuesdays, at 5.30 p.m., commencing February 20.

"THE EXPANSION OF EUROPE OVERLAND: THE ROUTE OF THE STEPPES."

The first of these lectures will be illustrated by lantern slides.

By A. J. Toynbee, M.A., Professor of Modern Greek.

DEPARTMENT OF ZOOLOGY.

A Course of Three Public Lectures (arranged by the University), on February 20, 22, and 23, at 5.15 p.m.

"THE BIONOMICS OF MARINE ANIMALS."

By J. H. Orton, D.Sc.

FACULTY OF LAWS.

A Public Lecture (arranged by the University), on Friday, February 9, at 5.30 p.m.

"CHIEF JUSTICE SIR WILLIAM BEREFORD."

By W. C. Bolland, M.A., Sanders Reader in Bibliography at the University of Cambridge.

DEPARTMENT OF ENGINEERING.

Three Courses of Advanced Lectures for Post-Graduate and other Advanced Students.

1. "Recent Developments in Electrical Traction." Three lectures by F. Lydall, B.A., B.Sc., M.I.E.E., on Tuesdays, at 5.30 p.m., beginning January 23.

2. "Recent Developments in Central Station Design." Three lectures by W. B. Woodhouse, M.Inst.C.E., M.Inst.E.E., on Mondays, at 5.30 p.m., beginning February 12.

3. "The Erection of Steelwork." Three lectures by J. Stuart Lewis, on Tuesdays, at 5.30 p.m., beginning March 6.

These lectures are free only to engineering students of the College.

SHAKESPEARE ASSOCIATION.

Friday, January 26, 5.30 p.m.: Professor Parrott, of Princeton University, "Timon of Athens."

Friday, February 16, 5.30 p.m.: Dr. Scripture, "Shakespeare's Verse in the Light of Experimental Phonetics." (With lantern illustrations.)

Friday, March 16, 5.30 p.m.: Bibliographical Meeting.

OTHER ARRANGEMENTS.

Wednesday, January 17: College Term begins. 10 a.m. Service in the College Chapel.

Thursday, January 18: University Term begins.

Monday, January 22, 6 p.m.: Gilbart Lectures on Banking, first of a course of four lectures by Mr. Heber Hart, K.C.

Thursday, March 15, 6 p.m.: Gilbart Examination.

Wednesday, March 28: College and University Terms end.

ERNEST BARKER, M.A., D.LITT., LL.D., *Principal.*

W. R. MATTHEWS, M.A., D.D., *Dean.*

S. T. SHOVELTON, M.A., *Secretary.*

UNIVERSITY OF BIRMINGHAM.

Principal Grant Robertson, of the University of Birmingham, states, in his annual report, that the Standing Joint Committee of Council and Senate "to organise a policy of research" has been in full working for the whole session. The appointment of the Committee was a wise step, excellent work having already been done. It is clear that the existence of such a Committee has stimulated the impetus towards research, and that the number of applications from the staff will increase. It is, above all, important that research (he says) should not be identified solely with work carried on by the Faculty of Science, essential as that is, but that every Faculty should realise that original contributions to knowledge are a duty, which is closely connected with efficiency in teaching, and that the influence thereby exercised on the students is incalculable alike in its value and in the attitude of mind it can create.

CUPROUS SULPHITES.

It was suggested in a previous communication, published in *The Chemical News* of March 4, 1921, that the yellow cuprous oxide, obtained by an alkaline solution of cupric sulphate with glucose, might contain an appreciable amount of cuprous hydroxide. Attempts were made to prepare cuprous salts of some oxygen acids with this yellow oxide. In the course of these trials a red variety of basic cuprous sulphite was detected. Its method of preparation and properties are detailed below.

KNOWN SULPHITES.

Besides the white cuprous sulphite, obtained by passing sulphur dioxide through a solution of cuprous acetate in acetic acid, a garnet-red cupro-cupric salt (Sp. Gr. 3.57)—Cu_2SO_3, $CuSO_3$, $2H_2O$—is

known to exist. It is prepared by heating the double salt, cuprous ammonium sulphite. Another cupro-cupric salt—Cu_2SO_3, $CuSO_3$, $5H_2O$—greenish yellow in colour, is also mentioned.

PREPARATION.

Basic cuprous sulphite can be prepared by saturating, with sulphur dioxide, a weak solution of sodium or potassium hydroxide in which yellow cuprous oxide is suspended. A bright red, heavy (Sp. Gr. 3.26) granular precipitate settles down in a few minutes. The substance so prepared was washed free from sulphites and other impurities, dried at 105° C., and used in the following experiments.

PROPERTIES.

1. When heated in a test tube, the substance loses SO_2 and H_2O, the residue becoming yellow, then red, and finally black. When gradually heated in the air-oven, it undergoes no change up to 145° C., when it begins to lose water. The residue—greyish yellow in colour—contains cupric sulphate and bright yellow cuprous oxide.

2. When boiled with water, a small portion of the salt is readily hydrolysed, and a bright lemon yellow substance sticks fast to the bottom of the vessel as a thin layer. It readily dissolves in caustic alkalies, forming a pale blue solution. The rest of the substance slowly hydrolyses with the formation of cupric sulphate and yellow cuprous oxide.

3. With dilute hydrochloric acid cuprous chloride is formed with the evolution of sulphur dioxide.

4. With dilute alkalies a pale blue solution containing alkali sulphite is formed and yellow cuprous oxide is deposited with no trace of cupric hydroxide. When the blue solution is warmed, yellow cuprous oxide is thrown out, and pure alkali sulphite remains in solution.

5. The substance is not affected by sulphurous acid.

COMPOSITION.

To ascertain the composition of the substance several determinations were made which gave consistent results with the following percentages:— %

(a) Cu—estimated as CuO 50.46

(b) SO_2—estimated as SO_2 by treating the salt with dilute HCl and absorbing the SO_2 in NaOH 21.15

(c) H_2O—calculated from loss of weight on heating the salt in air oven up to 160° C. 4.65

(d) The substance, after heating in the air oven up to 160° C. was treated with water; the resulting yellow cuprous oxide was washed free from $CuSO_4$, dried and reduced to metallic copper in a current of hydrogen. The percentage of copper was found to be 59.12, giving the formula $Cu_2O,4H_2O$ to the yellow oxide. Hence the H_2O and O_2 which are in combination with copper as this hydrated yellow oxide must account for the remaining 23.74 per cent. of the salt required to complete the percentage composition of the substance (100-76.26) 23.74

These percentages do not accord with the composition of either of the cupro-cupric salts mentioned above. The general behaviour and percentage composition, as given above, point to the conclusion that the red substance under investigation is a basic cuprous sulphite and cannot be identified with either of the cupro-cupric sulphites which are known to exist. Its formula—which accords with its percentage composition — may probably be $Cu(Cu_2O.4H_2O)SO_3$, H_2O, in which a molecule of hydrated yellow cuprous oxide takes the place of one hydrogen atom in sulphurous acid while the other hydrogen atom is displaced by monovalent copper.

V. V. SARMA.

Govt. College Laboratory,
Kumbakonam, S. India.
20th December, 1922.

GENERAL NOTES.

PREPARATION OF A TRIOXYMETHYLENE.

BY D. L. HAMMICK AND A. R. BOERCK.

a Trioxymethylene is a polymeride of formaldehyde, and can be prepared by a modified form of Pratesi's method, which consists in heating 10 pents of paraformaldehyde and one part of 1:1 sulphuric acid in a vacuum tube to 115° C. in an oil bath. The crystalline trioxymethylene forms in slender needles on the cool part of the tube. The yield of purified substance is 10 per cent. Better results were obtained on the

lines of Auerbach and Barschall's process under definite conditions. By repeated sublimation of α trioxymethylene, a new polymeride, ε polyoxymethylene, is formed.—(*Trans. Chem. Soc.*, 1922, p. 2738.)

ABSORPTION OF CARBON DISULPHIDE VAPOUR.

By A. J. Currier and A. W. Browne.

For the absorption of carbon disulphide vapour from gases, the authors propose to use a solution of sodium trinitride,

$$NaN_3 + CS_2 = NaSCSN_3,$$

in which the trinitride and carbon disulphide combine to give sodium azido-dithiocarbonate. The strength of the sodium trinitride solution should be at least 5 per cent., and although aqueous solutions of sodium azido-dithiocarbonate decompose to give free nitrogen gas, this decomposition is too slow to affect the results in gas analysis.—(*J. Am. Chem. Soc.*, 1922, p. 2849.)

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs Advisory Licensing Committee.

The Board of Trade announce that on the nomination of the Association of British Chemical Manufacturers, they have appointed Mr. W. H. Dawson, the Manager of the British Alizarine Company, Limited, Trafford Park, Manchester, to be a member of the Dyestuffs Advisory Licensing Committee, set up under Section 2 (3) of the Dyestuffs (Import Regulation) Act, 1920, in the place of Mr. E. V. Evans, O.B.E., F.I.C., resigned; and that they have appointed Mr. Lionel Blundell, of the North British Chemical Co., Ltd., Droylesden, Manchester, to be a member of the Dyestuffs Industry Development Committee, set up under Sub-Section 2 (6) of the Dyestuffs (Import Regulation) Act, 1920, in the place of Mr. E. V. Evans, O.B.E., F.I.C., resigned.

Board of Trade, 10th January, 1923.

PERU.

A Land of Mystery.

Peru, in which once flourished the ancient civilisation and culture of the Incas, is still a land of mystery. Though not large as South American Republics are measured, it is three countries with three distinct climates. The tropical lowlands of the steaming Amazon valley are cut off from the temperate coast region of the Pacific by mountain ranges within which dwell Indians in a low state of civilisation and in a chronic condition of unrest. The dry coast strip, cooled by the Humboldt current, contains the principal cities and most of the white population of some 700,000 people. There is here little or no rainfall, the land is cultivated by irrigation, and the products are cotton and sugar, wool, hides and skins, and petroleum. This coastal strip, though limited in area, is the chief district in which agriculture and pasture flourish. The rain, which is denied to the coastal region by the barrier of the Andes, falls abundantly all the year round n the mountain districts. But though the soil of the eastern slope is rich, the lack of transport makes it unproductive. It is this unexploited and almost impenetrable mountain region which so effectively cuts off the Amazon valley from the Pacific coast that it needs to be approached from the Atlantic side. We see in this great valley illimitable forests, yet all the timber used on the Pacific coast has to be imported from overseas. The collection of wild rubber has declined with the fall in the price of the marget commodity. About Iquitos in the upper waters of the Amazon lie an indefinite number of rich agricultural acres which, under happier geographical circumstances, could support a large population, yet there is at present no more than one human being to every two and a half square miles. Iquitos is over a month's journey by land from Lima, the capital of Peru, on the Pacific coast, and a voyage by sea, the Panama Canal and the Amazon from Callao to Iquitos, recently occupied a steamer no less than 80 days. The mountain barrier, which has remorselessly cut off the comparatively civilised coast from its hinterland by the Amazon, has set the white Peruvians an economic problem which is as yet far from solution.—*Board of Trade Journal.*

ON A RECENTLY FOUND METEORIC IRON FROM GLASGOW, BARREN COUNTY, KENTUCKY.

By George P. Merrill.[1]

(From "The American Journal of Science," January, 1923.)

The iron meteorite briefly described below was first brought to my attention in

June, 1922, by Prof. Arthur M. Miller, of Lexington, Kentucky, by whom it has since been given a brief notice in *Science for September 1*, page 249.

According to Professor Miller, two pieces of the iron were found during the work of ploughing a field for three miles south-west of Glasyow, in Barren County. The pieces are stated to have weighed about 25 and 20 pounds respectively, and while very badly oxidised, exhibited on broken surfaces, even without etching, coarse Widmanstätten figures. The smaller of the two pieces was sent yy Professor Miller to the National Museum, and it is upon this piece that the description here given is vased. As received, the mass weighed but about 7 kilograms (15¼ lbs.).

The iron is of the ordinary octahedral type, with kamacite lamina from 1 to 2 mm. in thickness, and is therefore classed as a coarse octahedrite. No troilite nodules are visible on the cut surface and neither tænite nor schreibersite are conspicuous. Plessite areas are small. The iron is in an advanced condition of oxidation that is difficult to arrest, suggestive of a high content of lawrencite. An analysis by Dr. J. E. Whitfield yielded:

	Per cent.
Iron	70.632
Nickel	7.270
Cobalt	0.620
Sulphur	0.110
Phosphorus	0.121
Carbon	0.062
Chlorine	0.363
Nickel iron oxides	19.220
Silica	Trace
Ignition	1.650
Total	100.048

Satisfactory chlorine determinations in meteoric irons are none too abundant. Cohen gives figures running from 0.003 to 1.48 0per cent. There are reasons for supposing that the higher are not absolutely correct. Be this as it may, Whitfield's find of 0.363 per cent. Cl, equivalent to 0.623 per cent. $FeCl_2$, is high, and doubtless accounts for the too ready disintegration mentione dabove.

U.S. National Museum.
Washington, D.C.

[1] *Published with the permission of the Secretary of the Smithsonian Institution.*

New Patents.

THIS list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

35356—Ashai Glass Co.—Forcing agent of manure. Dec. 29.
3522—Edwards, G. W.—Treatment of oxidised copper ores. Dec. 27.
35502—Therma; Industria & Chemica Research Co.—Apparatus for heat-treatment by molten metal. Dec. 20.

Specifications Published this Week.

190212—Mond, A. L.—Process for the continuous leaching of ores, metallurgical products, and other materials on the counter-current principle.
190246—Perkins, W. G.—Treatment of copper ores.
190269—British Cellulose and Chemical Manufacturing Co.—Treatment of cellulose acetates.
174041—L'Air Liquide Soc. Anon Pour L'etude et L'Exploitation Des Products.—Apparatus for the synthesis of ammonia.
190390—Bichowsky, F.—Processes for the synthetic production of alkali metal cyanides.

Abstract Published this Week.

Titanium-Nitrogen Compounds.—Patent No. 188558.—Messrs. Bichowsky, F. von, and Hartham, J., of 1412, San Fernando Building, Glendale, California, U.S.A., have developed a process for the production of the above compounds. They are produced by heating a mixture of ilmenite, carbon, and an alkali-metal compound containing oxygen but not containing sulphur, in presence of nitrogen or gaseous mixtures containing the same, the temperature being slightly below the melting point of the mass. The carbon may be supplied as soot, coke, or a compound containing carbon, such as crude oil, and these materials may be supplemented, or even supplanted, by gaseous mixtures containing hydrocarbons, such as natural gas. In one example, 100 parts of finely ground ilmenite, 5 parts of anhydrous soda ash, and 10 parts of pitch are briquetted and heated under slight pressure for six hours in presence of natural gas containing 20 per cent. by volume of nitrogen. The temperature may be at first between 1,100-1,200° C., but is finally maintained at 1,000-1,100° C. to avoid melting the iron. The product is allowed to cool in an atmosphere of neutral gas, and the iron dissolved out with warm dilute sulphuric acid. Another example illustrates the use of crude oil tar as the reducing agent, and sodium silicate and soda ash as the alkali-metal compounds. The titanium nitride or cyanonitride obtained may be used for the preparation of ammonia, or directly as a fertiliser.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,
VOL. CXXVI. No. 3277.

BRITISH INDUSTRIES FAIR, 1923.

VIII.—Stationery and Printing Sections.

The Paper, Printing, Stationery, and Office Appliance Sections of the Fair form one of the largest groups exhibiting, and all the various trades connected with these important industries will be well represented.

A well-known firm of paper makers will be exhibiting their noted tinted papers, which are guaranteed fast to light. This firm also make a speciality of coiled papers in all widths. Others will be showing a large range of papers and boards, together with manufactured stationery, and office furniture, while another leading firm, who have recently installed modern and complete plant for the purpose of manufacturing crepe papers of all kinds, including decorative crepe papers suitable for window dressing and all kinds of advertising matter, will display a complete range of their products.

In the Printing Section there will be a number of the large printing firms, embracin gall the different processes of printing for the production of works of art, and commercial printing, such as catalogues, posters, etc.

The art of colour printing in the United Kingdom has of late years made so much progress that we may be said to be in advance of the whole world. In particular we are specially predominant in the three and four colour processes, and there are many firms with hundreds of pretty subjects in various sizes suitable for use as fancy box-tops, calendar tops, advertising showcard tops, as well as for framing or decorative purposes. The smaller nations have neither the means of producing good colour work nor the population that would make such production a commercial selling proposition ;therefore, such goods are imported. Germany for many years did an enormous trade in cheap colour reproduction for the above purposes, but first cost of blockmaking and printing are so high now that German firms are largely selling old subjects.

United Kingdom firms are still publishing, and, bearing in mind the greater interest to the Empire of British scenes and subjects as against German designs, which usually show foreign figures and landscapes, many enquiries for these lines are

PLANNING COMMERCIAL VICTORIES.

Great Display of Electrical Exhibits at Wembley.

More than half the space available for electrical engineering exhibits at the British Empire Exhibition has been booked already.

In this section, with an area of 200,000 square feet, organised by the British Electrical and Allied Manufacturers' Association, there will be a mile of gangways for the visitor to walk, and nearly two miles of stand frontages to be visited.

The electrical industry is one of the youngest of the great industries of the world, but every year brings new inventions, developments and improvements, and in 1924 the public will realise as never before what this industry means and what it offers to them. It is clear that the organising minds intend to prove to the world that the capacities and resources of the industry are co-extensive with the Empire itself.

Women will be shown what electricity can do for them in their homes. Electric labour-saving devices, electrical appliances for the preparation and cooking of food, washers, cleaners, irons, kettles and the innumerable appurtenances of the modern home will be demonstrated in infinite variety.

Among the many exhibits of interest to the technical and non-technical visitor alike are :—

Electrical accessories, accumulators, alternators, bells, batteries, cables, carbons, controllers, condensers, dynamos, generators, high tension fuses, instruments, insulating materials, lamps, meters, magnets, motors, models of workshops, power plant, rotary converters, searchlights, switchgear, starters, telephones, turbines, transformers and wiring supplies.

The millions of visitors to Wembley will be shown that the British electrical industry possesses a technical ability and a manufacturing capacity which maintain the best traditions of British commerce, and an effort will be made to educate the public and to create in them the desire to possess the many advantages which the use of electricity holds out to them.

To set up this mighty monument of electrical achievement before the world for six months means that the industry is planning great commercial victories for the future.

A NEW SYSTEM FOR THE LINEAR REPRESENTATION OF THE STRUCTURE OF ALL ORGANIC COMPOUNDS.

By T. Sherlock Wheeler, B.Sc., A.R.C.Sc.I., A.I.C.

(*Continued from Page 66.*)

The system can be employed in writing equations. It can also be used in conjunction with our present system if it be desired to show the exact course of a reaction graphically, so that it may be apparent at a glance. Much space can be saved in this way, and there is no loss in clearness. The equation :—

$$\text{Ar. VI. 1, 2 VI.}\begin{matrix}(4\text{-}CH_2.CH_2OH)\\(5\text{-}CH_2.CH_3)\end{matrix}\xrightarrow{-H_2O}\text{Ar. VI. 1, 2 VI. 4. 5 Al. VI.}$$

illustrates this.

In some cases it may be desirable for didactic purposes to represent a chain as part of a closed ring. To indicate this, the compound is described as if the ring were closed, and the fact that one bond is missing is shown by a bar *underneath* the numbers of the two carbons which it would join.

The above description is sufficient to enable any possible type of ring compound to be described. One further example may be given: XVIII. is the probable formula of cinchonine. It is Al. VI.′ (N-4) 4, 1 VI. 3, 3′ $\overline{\text{VI.}}$ (O-4) 5 II. 2 Ar. VI. (N-4) 5, 6 VI. The system is especially fitted for dealing with these polynuclear compounds so common in dye chemistry. Quinone, pyridine, thiophene, and such like structures are taken to come under the heading Ar, but if preferred Al can be placed before the symbols for the rings containing them and the double bonds indicated.

The following is a summary of the system:—

(i) A "structure line" is drawn, passing in ring compounds through the centres of rings and along chains joining rings. In open chain compounds the lines pass along the longest chains, and then *along the branches; the longer branches are* included as far as possible in the main structure line.

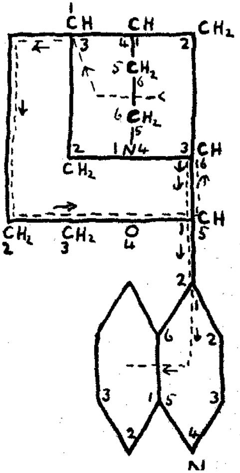
(ii) Rings are numbered clockwise from the extreme left-hand common carbon; chains are numbered in the direction of the structure line from where it joins them; common carbons are included in each ring and chain in which they occur.

(iii) The number of elements in a ring is *shown by plain Roman numerals; for a* chain barred Roman numerals are employed.

(iv) *All* information about a ring or chain comes immediately after its Roman numeral, if possible; where it is necessary to refer back to any ring or chain, its symbol *is labelled, so to speak, with an index.*

(v) Substituents come after the number of the element to which they are attached; non-carbon elements precede the number *of the place they occupy.*

(vi) The extreme left and then the extreme right hand carbons common to two rings are shown in that order, between the numerals *for the rings by their numbers in*



XVIII

the first ring. The single common carbons connected with chains are shown in a similar manner.

(vii) Ar. shows that the ring or rings following are aromatic, *i.e.*, can be written with a centric formula; Al. shows them alicyclic, *i.e.*, fully reduced.

(viii) A bar under the numbers of two carbons shows that the link joining them is to be removed *after* the compound is drawn as indicated.

(ix) Stereo-chemical terms are unaltered. Cis and trans come in between the representations of the groups or elements to which they refer. Fischer's system is used for indicating the orientation of asymmetric carbons in sugars, etc.; cis and trans compounds can also be shown on that system.

From the examples given, it will be seen that the system is capable of indicating any compound, no matter how complicated. In some cases the description is, of necessity, long, but it is never hard to unravel once the few simple rules are known. In fact after some little practice, the general structure of a compound is apparent at a glance from its description, while to describe a compound the structure line need never be more than drawn mentally. Where there are several ways of describing a compound on the system, the shortest is of course always to be preferred, and its use would be fixed in practice, but any of the ways available will yield up the formula when required. It is to be hoped that the scheme described will find a ready use in chemical dictionaries, chemical abstracts, chemical journals, and perhaps advanced text-books. In elementary text-books and all such cases where obviousness is of more importance than conciseness, the present day graphical formula would still, of course, want to be given directly; having to "translate" a concise but complete method of representation might perhaps confuse a beginner. Although the system does not seek in any sense to name the compounds described, yet it can be used as a basis of a system of nomenclature. This aspect of the matter will be dealt with later.

The author's thanks are due to Dr. A. M. Patterson, of Xenia, Ohio, for his helpful criticism of the above.

NOTES ON THE ACTIVE PRINCIPLES OF SOME SOUTH AFRICAN PLANTS.

By Charles F. Juritz, M.A., D.Sc., F.R.S.S.Af., F.I.C., Chief of Division of Chemistry, Department of Agriculture, Union of South Africa.

Up to the present, comparatively little investigation has been carried out by chemists in South Africa with relation to the active principles of South African plants. When I first drew public attention to the subject,[1] after alluding thereto more or less incidentally in many successive annual reports, practically no attention had been given to it outside South Africa, but to-day such names as those of Power, Salway, Rogerson, Tutin, Dunstan and Holmes testify to the interest which this branch of South African plant chemistry has aroused in other lands.

Within the borders of the Union of South Africa, however, the matter still stands near where it stood when I first voiced my plaint in 1905, and the *chemical* investigation of the poisonous and perhaps pharmacologically valuable principles of our flora scarcely advances further than the strict requirements of the courts of justice when Kaffir "medicine men" are being tried for culpable homicide.

Sixteen years have passed since the date of my first publication (alluded to above), and on four subsequent occasions[2] the great desirability of making a special feature of this phase of chemical research in South Africa has been strongly urged, but for a long time it seemed vainly. And yet it has not been altogether in vain: Dr. Rindl,

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[1] "*Some notes regarding South African Pharmacology*," *Trans. S.A. Phil. Soc.*, Vol. XVI., pp. 111-118.

[2] *R. Marloth*, "*The Chemistry of some vegetable products of South Africa*," *C.G.H., Agricultural Journal*, 1909, pp. 634-638.

R. Marloth, "*The Chemistry of South African plants and plant products*," *Cape Chemical Society*, 1913.

C. F. Juritz, "*South African plant poisons and their investigation*," *Rept. S.A. Assoc. for Adv. of Science*, 1914, pp. 109-145.

C. F. Juritz, "*The Urgency of a definite forward movement in the study of the active principles of South African plants*," *S.A. Medical Record*, Nov. 13, 1915.

Professor of Chemistry at Grey University College, Bloemfontein, has definitely undertaken as a subject for research the study of South African pharmacology from a chemical standpoint, and a year or two ago Dr. J. W. C. Gunn was appointed Professor of Pharmacology at the University of Cape Town, and he has since undertaken systematic determination of the physiological action of plant substances peculiar to the flora of South Africa.

The facilities afforded by the establishment of a fully equipped Department of Pharmacology of the University in the vicinity of the laboratories of this Division in Cape Town, will enable the two institutions to co-operate in regard to the investigation of anygation of any plant supposed to be physiologically active: in fact, Prof. Gunn has already, in two cases, published the results of experiments which have been carried on in his laboratories, while such chemical work as has been possible was being performed in the laboratories of this Division. This will appear from the subjoined notes on three South African plants.

I.—Wild Celery [Peucedanum galbanum (L.)], Benth. and Hook.

Some time ago statements regarding the therapeutic value of wild celery in cases of Bright's disease, and dropsy resulting therefrom, went the round of the South African press. Instances were quoted of persons who had suffered from the chronic disease for years, and had frequently been surgically tapped without more than temporary relief, but who had been restored to health after a few months' use of the above plant.

Dr. R. Marloth, in his "Dictionary of the Common Names of Plants,"[3] and also in his "Chemistry of South African plants and plan tproducts,"[4] identifies this "wild celery" with *Peucedanum galbanum* (L.), Benth. & Hook (Natural Order Umbelliferæ), and in the latter publication makes the following further reference to it:—

> "The fresh plant contains a very volatile essential oil, which, when applied to the skin, causes severe dermatitis. Some persons are so sensitive that the mere touching of the leaves will produce blistering of the skin, generally about 30 or 40 hours afterwards, although the contact itself causes no irritation."

On account of this property the plant also very well known under the name " Blistering bush." It is common on th mountains around Cape Town, and an in fusion of the leaves is largely used among the coloured classes of the peninsula as diuretic.

An investigation of the fresh gree leaves, kindly supplied by Mr. C. R. Ros Conservator of Forests, Western Conse vancy, was undertaken in the laboratorie of the Division of Chemistry at Cape Tow by Mr. W. J. Copenhagen, steam distill tion of from 3 to 8 kilos. at a time bein carried on for extraction of the volatile oi The quantity of the latter obtainc the fresh leaves. It was light brown i colour, and possessed the strongly aromati odour which characterises the plant. Th following physical constants were found:

Specific gravity at 24° C. 0.847
Refractive index at 40° C. 1.4742

When the previously steam-distilled o was collected and heated to 85° C., it dis tilled over, apparently breaking up simu taneously into fractions.

With a view to testing the supposed ves cant properties of the oil, it was applied t the arms of a number of persons withou any irritating effect being noticeable, eithe immediately or after the lapse of time. Th leaves, both fresh and dried, were similarl experimented with, also without any blis tering effects.

In order to permit of more precise phy siological tests, some of the volatile oil wa sent from this laboratory to the Pharm cology Department of the University Cape Town, and a note by Prof. J. W. (Gunn and Dr. E. M. K. Geiling on the experiments with it was subsequently pub lished in the *South African Medica Record*.[5] Some of their conclusions ar here quoted:—

> "The volatile oil . . . has a per sistent nauseating taste, but is not spe cially irritating to the mucous membran of the mouth or stomach. The oil wa rubbed into the skin of several people, but there was no sign of irritation apar from the initial redness caused by th rubbing. . . .

> "In our opinion, the irritant proper ties of the plant are not due to thi volatile oil. The length of time tha

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[3] 1917, p. 19.

[5] Vol. XVIII., 1920, p. 288.

[6] *The authors are not referring here to th similar test previously applied in the labora*

elapses before the onset of dermatitis after contact with the plant points rather to some non-volatile constituent as the cause.

"An infusion of the plant is sometimes used as a diuretic. In this respect it is probably as efficient as buchu, and could be used as a cheap substitute for the latter, but its unpleasant taste and the difficulty in handling it are disadvantages."

There are several South African species *Peucedanum*. Harvey and Sonder enu-.erate some two dozen (inclusive of *Bubon* id *Anethum*)[7]; and *P. galbanum* is by no .eans the only species which yields an .sential oil. Dr. Marloth[8] states that the .ant commonly known as wild parsley (*P. nuifolium Thumb.*) has a similar effect to .at produced by *P. galbanum*. *P. graveens* (L.), Benth. & Hook, also yields a .olatile oil (dill oil), and its fruit has for ng been used as a drug, both the fruit id the extracted oil being employed as an .omatic stimulant. In this connection E. Parry says,[9] "If the fruits can be pro-.ced in quantity in Cape Colony, they .ould form a most useful source of sup-.y." This remark seems to have been .ompted in part by the fact that J. C. .mney found the fruits of plants grown in .outh Africa to be slightly larger in size .an those grown in England, and to con-.in a slightly higher proportion of oil—..6 per cent., as compared with 10.9 per .nt.

—Slangkop (Urginea macrocentra, Baker):

quantity of bulbs of a species of slang-was brought to the laboratory by Mr. F. Wolff from Doornfontein, P.O. Wil-.ashof, Boshof, O.F.S., with the object ascertaining its value as a tanning ..erial. The poisonous qualities of some .ecies of slangkop are well-known: after .e dry season the first green vegetation to .pear in sight is the young shoot of this .ant; the sheep and goats nibble it off and .e, and hence many thousands are said to . lost annually. Mr. Wolff thought that if the bulbs could find useful application in the tanning industry, the country-side would simultaneously be delivered from a constant menace to stock-life.

There are several South African species of slangkop, or, as the genus called by that name in the Transvaal[10] is botanically known, *Urginea*. Not only are many species of this genus poisonous, but other genera of the Natural Order (Liliaceæ), such as *Ornithogalum* and *Bowiea*, have been partaken of with fatal effects either to man or stock. No less than 27 species of *Urginea* were enumerated by Thiselton-Dyer in *Flora Capensis* (Vol. VI., pp. 463-470). One of the best known species is *Urginea Burkei* Baker, commonly known as the Transvaal slangkop, and presenting to stock precisely the temptation already alluded to above. Of this plant Dr. Marloth says, "Nothing is known about its ingredients, and the antidotes employed are consequently quite empirical."[11] Then there are the purple slangkop, *U. sanguinea*, which is equally poisonous according to Dr. Marloth, and *U. altissima* Baker, or magerman, the bulb of which resembles the Mediterranean squill, *U. maritima* Baker, in its action.

U. maritima, which is found not only along the Mediterranean coast but also in the Cape Peninsula, contains a number of glucosides and other bitter principles, such as scillain or scillitin, and scillotoxin, belonging to the digitalis group, and producing effects somewhat similar to those of digitalis as heart poisons. In very small doses it is merely expectorant or diuretic, but in larger quantities it becomes emetic and purgative. For pharmaceutical purposes the bulb of this plant is divested of its dry membranous outer scales, cut into slices, dried, when it becomes brittle and is easily powdered. The dose is from 1 to 3 grains of the powder.

On *U. Burkei*, Mr. J. Burtt-Davy wrote a short note in the *Journal of Industries*,[12] mentioning that the plant is acrid and poisonous, causing inflammation of stomach and intestines and paralysis. He also had a longer account of the plant in

[7] "*Flora Capensis*," Vol. II., pp. 553-.1.

[8] "*Dictionary of Common Names of* .*ants*," p. 66.

[9] "*Chemistry of Essential Oils*," 3rd ed., .18, p. 294.

[10] The *Cape* slangkop is quite another plant—*Ornithoglossum glaucum* — which, however, is also poisonous.

[11] "*Chemistry of South African plants and plant products*": *Cape Chemical Society*, 1913, p. 5.

[12] Jan., 1920, p. 72.

the Report of the Transvaal Department of Agriculture for 1903-4, pp. 310-311, with *three illustrations, dealing inter alia* with the distribution of the plant, the season when it is most dangerous to stock, the symptoms of poisoning in stock, the local remedies, and other plants liable to be mistaken for slangkop.

The late Mr. L. H. Walsh, in his booklet on "South African Poisonous Plants," has two half-tone photographs of *U. Burkei*, with a description of the plant (pp. 31-32). "In Griqualand West and Bechuanaland," *he says*, "*numbers of sheep die* yearly from eating it, and in many districts of the Transvaal, notably Klerksdorp, its fatal properties are well known. . . . After the early rains, the flower spike appears with the first green herbage, and is eaten by the hungry stock, while later the leaves make their appearance, and claim fresh victims." At the close of his note, Mr. Burtt-Davy remarked, "If the active principle contained in *Urginea Burkei* should prove to be similar to that found in the squill, and of equal value, our native bulb might not only replace the imported drug, but might *also become an article of export. Incidentally such commercial* use of the plant would assist in clearing the country of a poisonous plant detrimental to the live-stock industry."

To return to *U. macrocentra*: the specimens sent to the Cape Town laboratory by Mr. Wolff were there examined by Mr. W. J. Copenhagen. The bulbs averaged 11 cm. in diameter and 380 gms. in weight. When fresh they contained 66.36 per cent. of moisture, and the proportion of tannin, determined by titration with potassium permanganate in the presence of indigo-carmine,[13] amounted to 0.53 per cent. of the fresh bulb. Obviously there is not much to be hoped for from such an article as a commercial tanning material. The bulbs were therefore minced and extracted, with a view to ascertaining their pharmacological potentialities. On extraction of the air-dried bulbs (containing 10.37 per cent. of moisture) with alcohol, after acidifying in the usual way, Mr. Copenhagen obtained 0.13 per cent. of the crude active principle. A 5 per cent. solution of this in 50 per cent. aqueous alcohol was prepared, and 1 cc. of this solution, injected subcutaneously into a guinea pig, caused death in from 7 to 10 minutes. This crude active principle formed precipitates with picric acid, gold chloride, and iodine in potassium iodide: it reduced Fehling's solution when boiled therewith.

The following colour-reactions were obtained:

Concentrated sulphuric acid—Brick red to violet.

Fröhde's reagent—Green.

Erdmann's reagent—Pink to red.

Mandelin's reagent—Red through pink to violet.

Sulphuric acid and potassium dichromate—Pink to dark brown.

Greenish[14] enumerates the following results of chemical investigations of squill, *U. scilla* Steinh. (*U. maritima* Baker):

"The constituents of squill [he says] are imperfectly known. Merck (1879) separated scillitoxin, scillipicrin, and scillin, all of which exhibit glucosidal properties. Scillitoxin and scillipicrin are both amorphous and act upon the heart, the former being the more active of the two; scillin is crystalline, but it is inactive. Scillain (Jarmerstedt, 1880) appears to be a purer form of scillitoxin. Waliszewski (1893) separated scillinin, schillipicrin and scillamarin. Kopaczewski (1914) isolated scillitin and scillidiuretin; scillitin (0.2 to 0.37 per cent.) is an intensely bitter, purified form of scillitoxin and probably the active constituent in the purest condition yet obtained."

In order that the precise pharmocological action of the slangkop bulbs might be tested, some of the latter were supplied to Dr. J. W. C. Gunn, Professor of Pharmacology at the University of Cape Town. Prof. Gunn has recorded the results in his experiments in a paper read before the Royal Society of South Africa,[15] where he sums them up by saying that the action is the same as that of the digitalis bodies, a group which includes a number of substances of great medicinal value. Prof. Gunn thinks it possible that slangkop might replace squill in South Africa, and in fact may be found superior to the latter.

[13] *The method adopted in Leeds University Laboratory. H. R. Proctor: "Leather Industries Laboratory Book,"* 2nd ed., 1908, p. 227.

[14] "*Text book of Materia Medica*," 3rd ed., 1920, p. 388.

[15] *Trans. Roy. Soc. S.A.*, Vol. IX., Pt. II., 1921, p. 197.

(To be Continued.)

THE FORTHCOMING "BUSINESS EFFICIENCY."

Now that, according to the highest authorities, trade is on the turn, and there are unmistakable signs in every direction that such is the case, business men all over the country will welcome the unique opportunity provided by "Business Efficiency" for witnessing all the latest scientific and labour-saving devices for facilitating business.

"Business Efficiency" is undoubtedly the greatest commercial education movement of the day, and will demonstrate how one man, with the aid of modern office appliances, can do the work of ten, how maximum efficiency can be secured at *minimum cost, without interfering with* existing organisations, and how by the introduction of better methods, success can be established to the utmost degree.

This epoch-making event, which has been promoted to help along the commerce of the country, will be of absorbing interest to every business man and woman. Assembled under one roof, at the Central Hall, Westminster, from February 7 to 17, will be found the world's most modern and approved methods for enabling business firms to turn out more work at less cost. Mr. Neville Chamberlain, M.P., Postmaster-General, will officially open "Business Efficiency" on February 7, at 12 o'clock.

In view of the increased cost of labour and overhead expenses, it was imperative that some move of this kind should be initiated, and as "Business Efficiency" was so successful in this direction last year, it was decided to continue it again on a far more extensive scale. Consequently more than double the accommodation has been reserved for this year's effort.

*For the truth is that more than ever to-*day the world wants better methods and better service. The business prizes go to those who are most efficient. Greater efficiency is what builds business in times like the present. The old threadbare ideas and antiquated methods will not suffice, and business men have got to keep up-to-date all the time.

"Business Efficiency" recognises that improved ideas have made the world what it is, and will shape the world of to-morrow. It is a co-operative effort of business men *for the information of business people ex-*clusively.

Experience has proved that the office is the brain system of every business firm; it is the nerve centre from which the executives direct and control the entire establishment, and when functioning on Business Efficiency lines *radiates efficiency* to every department. The great need for better methods in all administrative and executive departments of commerce is not fully appreciated. How to reduce unnecessary labour and increase individual and collective results is a problem every business man seeks to solve.

"Business Efficiency" shows how a far greater turnover can be secured for every individual firm, how the costs of production can be lowered in both office and works, and how future dividends can be *paid out of savings. This is the psychological* moment, when British trade is reviving, for business firms to take advantage of every possible appliance which will speed up production in every department.

There are devices to be exhibited which reveal a hundred and one ways of conducting business more efficiently and getting administrative work accurately and scientifically done. With the aid of these various appliances the amount of work the individual can do is enormously increased, and, many hours are thus saved from routine duties *for more creative* and profitable work.

The exhibits range from the very latest telephone system, by means of which two persons in different parts of an extensive building can speak to each other from whatever part of the room in which they happen to be without the necessity of raising the mouthpiece. This alone is a marvellous invention—worth going to see.

Another amazing example of efficiency is the latest calculating machine. In an instant, by a shuffle of the index cards, *answers to every conceivable* question relating to the customer can be obtained. Yet a further innovation is the complete office printer, which can be operated by junior clerks, and turns out every description of printing quickly at 50 per cent. less cost.

All the ingenious stamping contrivances, machines for protecting cheque-writers against fraud, all the modern systems of loose-leaf books, the latest carbons, ribbons, typewriters and recorders for checking piece work can be seen. In fact everything that *can possibly release human brains* and intelligence for work which is not mechani-

cal has been included, and the valuable time and expense thus saved to business firms is almost beyond calculation.

A word about the promoters—the Office Appliance Trades Association—whose membership consists of men who realise that the country's well-being greatly depends upon the advancement of efficiency in business.

The objects of the Association are the *linking up of the activities of those industries* which have already done so much to make business building and management easier and more harmonious, the spreading among British business people of further knowledge of commercial efficiency, and the general improvement of modern business conditions.

The Association makes no profit, for its members bear the expenses, and "Business Efficiency" is free to all desiring to improve their capacity for better business. Whatever the type of business, whether a one-man business or a gigantic organisation, "Business Efficiency" will show how things can be done better still. It will prove of invaluable benefit to the managing director, business organiser, business executive, manager, salesman, foreman, and all who are keen on the best methods for conducting business with efficiency and despatch.

More than ever to-day, the onus for the success of any business falls more heavily upon the individual member of the staff, in whatever capacity he happens to serve, *and "Business Efficiency" is of vital interest* to every business man. London's leading authorities on commercial efficiency will demonstrate the practical application of every new device, without any obligation, and admission is by invitation or presentation of business card.

To those desirous of forging ahead in business and anxious to take full advantage of every facility that will help in this direction, now that trade is on the turn, "Business Efficiency" provides a very real opportunity.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

ORDINARY MEETING—JANUARY 18, 1923.
Sir Charles Sherrington, President, in the Chair.

The following papers were read, the summaries here printed having been supplied by the authors for use at the meeting:—

J. BARCROFT, F.R.S. *Observations on the Effect of High Altitude on the Physiological Processes o the Human Body.*

Three principal factors appear to have a positive influence in acclimatization:—

(*a*) The increase in total ventilation, which usually raises the alveolar oxygen pressure ten or twelve millimetres higher than it would otherwise be;

(*b*) The rise in the oxygen dissociation curve so that at any oxygen pressure the hæmoglobin will take up more oxygen than before;

(*c*) The rise in the number of red corpuscles, and correspondingly in the quantity of hæmoglobin.

These factors were provisionally treated as independent variables. In reality they are not so, for blood can be made artificially to resemble high-altitude blood, by shaking out the CO_2 and then withdrawing a portion of the plasma, so that the blood is richer in corpuscles. Such blood has been found to give, at the alveolar CO_2 pressure of the Andes (27 mm. CO_2 or thereabouts):—

(1) A reaction which is apparently almost unchanged, or even more acid, as measured by the ratio of combined to free CO_2;

(2) A more alkaline reaction by the platinum electrode;

(3) An oxygen dissociation curve which rises apparently out of proportion to the change in reaction.

Herein would appear to be the essence of the acclimatory process. The possibility of the oxygen dissociation curve altering *owing to a specific loss of* CO_2 appears to be ruled out. There was an increase in the hæmoglobin value of the blood and in the red cell count in all cases. On making the ascent, there was a marked increase in the number of reticulated red cells, after the descent these cells fell to below their normal percentage. In the natives the ratio of reticulated to unreticulated red cells was not greatly increased, but the absolute number of reticulated cells per cubic millimetre was about 50 per cent. greater than normal. We argue a hypertrophy in the bone marrow. There were no nucleated red cells. The increase in red blood corpuscles is such as to cause an absolute increase in the amount of oxygen in each cubic centi-

metre of blood in the majority of cases, in spite of the decrease in saturation.

A number of mental tests of the ordinary type were performed at Cerro and at sea-level. These revealed no particular mental disability in the Andes, but, in our opinion, as well as in that of psychologists whom we have consulted, we have shown rather that our tests were inadequate than that our mental efficiency was unimpaired.

A number of tests were made for the purpose of discovering whether the pressure of oxygen in the blood was or was not higher than that in the alveolar air. In all cases they were so nearly the same that we attribute the passage of gas through the pulmonary epithelium to diffusion.

PROF. E. W. MACBRIDE, F.R.S. *Remarks on the Inheritance of Acquired Characters.* (Verbal communication only.)

It is well known to zoologists that during the last fifteen or twenty years a series of experiments have been carried out by Dr. Paul Kammerer at Vienna, which tend to show that acquired qualities or, in other words, modifications of structure induced by modified habits, are inheritable. The results of these experiments have been received with much scepticism, both here and on the Continent, and the *bona fides* of Dr. Kammerer has been called in question.

One of the most interesting of his experiments was in inducing *Alytes*, a toad which normally breeds on land, to breed in water. As a result, after two generations, the male Alytes developed a horny pad on the hand, to enable him to grasp his slippery partner.

It has been admitted by Kammerer's critics that if he could demonstrate this pad, he wolud to a large extent succeed in establishin gthe validity of his results.

This summer, at my request, Mr. J. Quastel, of Trinity College, Cambridge, when in Vienna, interviewed Kammerer, and was shown by him one of these modified males. Quastel photographed the animal, and enlargements from his photographs are now shown. Subsequently, at my request, the Zoological Society despatched Mr. E. Boulenyer on a visit to Vienna. He, too, saw the modified male, and was assured by Przibram, the head of the Biological Institute, that all Kammerer's experiments had been done under his (Przibram's) supervision, and were perfectly genuine.

C. F. COOPER. *Baluchitherium osborni* (? syn. *Indricotherium turgaicum*, Borrissyak.) Communicated by Dr. A. S. Woodward, F.R.S.

Baluchitheriu mosborni is an aberrant rhinoceros of such unusual size as to be apparently the largest known land mammal. The remains of this animal were first found in Baluchistan, and are described in the present Paper. Subsequently, further fragments have been found in Turkestan, and quite recently more material, as yet undescribed, in China.

While resembling the rhinoceroses more more than any other of the Perissodactyla, *Baluchitherium* is still isolated and of uncertain zoological position. There are certain adaptations to weight which have brought about a superficial resemblance in some of the limb bones of elephants. There are also resemblances in some of the foot bones and neck vertebræ to those of the horse, which are less easily explained, except by the hypothesis that this form is descended from a small eocene form, *Tripolpus*, which likewise shows an intermingling of horse and rhinoceros characters. In some structures, notably the excavations of the vertebral canal to ensure a combination of lightness and strength, *Baluchitherium* stands alone among mammals.

J. A. GUNN and K. J. FRANKLIN. *The Sympathetic Innervation of the Vagina.* Communicated by Sir Charles Sherrington, P.R.S.

H. G. CANNON. *On the Metabolic Gradient of the Frog's Egg.* Communicated by Prof. E. W. MacBride, F.R.S.

BASISWAR SEN. *On the Relation between Permeability Variation and Plant Movements.* Communicated by Sir William Bayliss, F.R.S.

H. L. DUKE, M.D. *An Enquiry into an Outbreak of Human Trypanosomiasis in a "Glossina morsitans" Belt to the East of Mwanza, Tanganyika Territory.* Communicated by Mr. C. Dobell, F.R.S.

LOUIS DOLLO, Sc.D. *Le Centenaire des Iguanodons* (1822-1922). Communicated by Prof. A. C. Seward, F.R.S.

THURSDAY, JANUARY 25, 1923, AT 4.30 P.M.

Papers read:—

PROF. A. V. HILL, F.R.S., *The Potential Difference occurring in a Donnan Equilibrium and the Theory of Colloidal Behaviour.*

E. F. ARMSTRONG, F.R.S., and T. P. HILDITCH, *A Study of Catalytic Actions at Solid Surfaces. X.—The Interaction of*

Carbon Monoxide and Hydrogen as conditioned by nickel at relatively low Temperatures. A Practical Synthesis of Methane.

J. Holker, D.Sc., *The Periodic Opacity of certain Colloids in progressively increasing Concentrations of Electrolytes.* Communicated by Prof. A. V. Hill, F.R.S.

E. K. Rideal and R. G. W. Norrish, *The Photochemistry of Potassium Permanganate. Part I.—The Application of the Potentiometer to the Study of Photochemical Change. Part II.—On the Energetics of the Photo-decomposition of Potassium Permanganate.* Communicated by Sir William Pope, F.R.S.

E. A. Fisher, *Some Moisture Relations of Colloids. I.—A Comparative Study of the Rates of Evaporation of Water from Wool, Sand and Clay.* Communicated by Prof. A. Smithells, F.R.S.

R. Whytlaw-Gray, J. B. Speakman, and J. H. P. Campbell, *Smokes, A Study of their Behaviour and a Method of Determining the Number of Particles they contain.* Communicated by Prof. A. Smithells, F.R.S.

R. Whytlaw-Gray and J. B. Speakman, *A Method of determining the Size of the Particles in Smokes. Part II.* Communicated by Prof. A. Smithells, F.R.S.

R. C. Ray, *The Effect of Long Grinding on Quartz (Silver Sand).* Communicated by Dr. M. W. Travers, F.R.S.

ABSTRACTS OF THE PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF LONDON.

January 10, 1923.

Prof. E. J. Garwood, Sc.D., F.R.S., Vice-President; and afterwards Prof. A. C. Seward, Sc.D., F.R.S., President, in the chair.

Prof. William Johnson Sollas, Sc.D., F.R.S., F.G.S., then proceeded to deliver a lecture on *Man and the Ice-Age.*

He said that, thanks to the researches of General de Lamothe, Prof. Depéret, and Dr. Gignoux, the Quaternary System now takes its place as a marine formation in the stratified series.

Four ancient coast-lines of remarkably constant height have been traced around the Mediterranean Sea and along the western shores of the North Atlantic Ocean. These, with their associated sedimentary deposits, form the successive stages of the Quaternary System: namely, the Sicilian (coast-line about 100 metres); the Milazzian (coast-line about 60 m.); the Tyrrhenian (coast-line about 30 m.); and the Monastirian (coast-line about 20 m.).

The Sicilian deposits rest unconformably upon the Calabrian (Upper Pliocene), and in their lower layers contain a characteristic cold fauna. The fauna of the Milazzian is warm-temperate, of the Tyrrhenian and Monastirian still warmer, for they contain numerous species of mollusca which now live off the coast of Senegal and the Canary Islands.

The three lower coast-lines correspond with the three lower river-terraces of the Isser (Algeria), the Rhône, and the Somme. Hence it may be inferred that the position of the river-terraces has been determined by the height of the sea-level.

The lower gravels of the three lower terraces of the Somme all contain a warm fauna, *Elephas antiquus* and *Hippopotamus*, and thus (like the corresponding marine sediments) testify to a warm climate. The climate of the Quaternary age was, on the whole, warm-temperate or genial, but interrupted by comparatively short glacial intervals.

The outermost moraine (Mindel) of the Rhône Glacier is associated with the Milazzian terrace, the intermediate moraine with the Tyrrhenian, and the innermost moraine (Würm) with the Monastirian; except for their serial order, these associations are (in a sense) accidental.

It is now possible to assign theu Palæolithic stages of human industry to their place in the Quaternary System: thus the "Strepyan" or pre-Chellean is Milazzian in age, the typical Chellean—Tyrrhenian, the evolved Chellean, Acheulean, and Lower Mousterian—early Monastirian, and the Upper Mousterian, Aurignacian, Solutrian, and Magdalenian—later Monastirian.

The coast-lines of the Northern Hemisphere appear to have their counterparts in the Southern Hemisphere, and the researches of Dr. T. O. Bosworth in Peru and Prof. G. A. F. Molengraaff in the East Indies have revealed extensive marine Quaternary deposits and successive movements of the sea-level.

The Quaternary movements are probably due to a general deformation of the globe involving eustatic changes in the level of the sea.

The lecture was followed by an interesting discussion, in which the following gentlemen took part: Mr. W. Whitaker, Mr. Walter Johnson, Mr. S. H. Warren, Prof. J. E .Marr, Prof. P. G. H. Boswell, Mr. H. Dewey, Mr. K. S. Sandford, and the Secretary.

At the meeting on Wednesday, February 7, a lecture on the "Geological Results of the Shackleton-Rowett (*Quest*) Expedition" will be delivered by Mr. G. Vibart Douglas, Geologist to that Expedition.

The Annual General Meeting of the Society will be held on Friday, February 16, at 3 p.m. The Fellows of the Society and their friends will line at the Cafe Royal (Regent Street, W.1) on the same day, at 7.15 for 7.30 o'clock.

ROYAL INSTITUTION.

On Tuesday, January 30, at 3 o'clock, Mr .R. D. Oldham began a course of two lectures at the Royal Institution on "The Character and Cause of Earthquakes"; on Thursday, February 1, Professor I. M. Heilbron delivered the first of two lectures on "The Photosynthesis of Plant Products," and on Saturday, February 3, Mr. J. C. Squire, Editor of the *London Mercury*, commences a course of two lectures on "Subject in Poetry," with special refercene to contemporary practice. The Friday evening discourse on February 2 will be delivered by Mr. C. F. Cross, on "Fact and Phantasy in Industrial Science," and on February 9 by Sir John Russell on "Rothamsted" and Agricultural Science.

THE SOCIETY OF DYERS AND COLOURISTS.

A meeting of the Manchester Section of the Society was held on January 19, when two papers of great interest were read. Mr. William Marshall, J.P., F.I.C., F.C.S., presided.

The Behaviour of Titanic Acid towards Dyestuffs, by J. K. Wood, D.Sc., F.I.C., and A. M. Morley, M.Sc.Tech., A.I.C.

Dr. Wood, in reading the above-titled paper, said the element titanium occurs in the fourth group of the periodic classification, together with silicon, zirconium, tin, and other elements. These elements form hydroxides which are amphoteric in character, and which are commonly referred to as acids. It has been customary to consider these substances as capable of existing in two modifications, known respectively as alpha and beta acids, and showing a considerable difference in behavious towards reagents. Although the practice has been to speak of only two varieties of the various acids, the facts recorded in the literature would suggest that more than two modifications are obtainable according to the methods of preparation which are employed. It is, however, extremely doubtful whether the substances referred to are definite hydrates of the oxide of the elements in question, and the opinion has gained ground in recent years that the difference between the so-called modifications of these acids is really due to a difference in size of their primary particles. The ortho acid, now commonly referred to as the alpha variety, is considered to exist in the form of small particles which are more readily attacked by reagents than the larger and more complex of the meta, or, as it is now commonly called, the beta acid. If the difference in property is really due to the size of the particles, it will be seen that this opens up the possibility of the existence of a number of modifications of the acids which would be in harmony with the behaviour as recorded in the literature. It has long been known that it is possible for the alpha modifications of these acids to be transformed into the beta varieties, and that, in turn, the beta may, under certain conditions, be re-converted into the alpha varieties, but no definite explanation of these changes and of the causes which operate to bring them about was offered until a few months ago, when, as the result of experiments on the stannic acids, Mr. Collins and himself suggested that the gradual change in the structure and properties of these properties might be traced to the amphoteric character of the oxides in question.

Mr. Collins and himself showed by papers published last year that the hypothesis is in agreement with the behaviour of Stannic Acids under varying conditions, and they also suggested that the isomerism of the analogous compounds of titanium, zirconium, and other elements, might be similarly accounted for. Numerous experiments which have been made with Mr. Morley show that this supposition that the explanation of the isomerism of the titanic acids was due to a similar cause is justified,

so that in regard to titanium hydroxide or titanic acids it may be assumed that between the so-called alpha titanic acid and the beta titanic acid, just as with Stannic Acids, there is a series of substances of *gradually increasing complexity of their* ultimate particles, and that there is really a continuous series of these substances gradually increasing in beta character as a process of condensation takes place as the result of the titanium hydroxide functioning in two capacities. This was more or less a theoretical statement which it was necessary to bear in mind with regard to the present position of knowledge regarding *these so-called isomeric acids. One result* of a process of condensation would be the gradual decrease in the total surface of the particles, because by the fusion owing to the process of condensation of several simple particles together, a complex particle was created, which must have a smaller surface than those from which it had been formed. Inasmuch as adsorption is a surface phenomenon it will be anticipated that, other things being equal, a sample of titanic acid having a pronounced beta character would possess a smaller adsorptive capacity than one in which the process of condensation had proceeded to a lesser degree.

A considerable number of experiments in support of the authors' deductions were explained.

Investigations on the Constituents of Raw Cotton, IV., by Professor E. Knecht, Ph.D., M.Sc.Tech., F.I.C., and G. H. Streat, M.Sc.Tech.

This paper was then read by Dr. Knecht, who stated that the title of the paper was rather a comprehensive one. It was really a second communication on cotton wax. In an account of the systematic extraction of the bleached cotton yarn which had been heated for 336 hours in a sealed tube at 93°, it was stated that the benzene extracted amounted to 0.3, alcohol 0.6, and water also 0.6 per cent. A partial confirmation of the assumption that these extracts were due to treatment in bleaching was *obtained at the time by extracting* some grey Egyptian yarn to exhaustion with benzene, then bleaching it, and extracting again with benzene, when a not inconsiderable further extract was obtained. The experiment was repeated later by Fernandez, and it was found not only benzene but also alcohol and water gav tracts after bleaching. It was further ascertained that cotton which had been thoroughly *bleached yielded, after being* smashed to powder on an anvil, considerable amounts of extracts. Further work *on this subject had now been carried out*, and the results generally confirm those rpeviously obtained. Briefly stated, the experiments showed that extraction of the raw cotton with benzene only removed the wax to the extent of about one-half, but that if the fibre substance is destroyed or disintegrated by chemical or mechanical means, the whole of the wax can be extracted, and is then found to amount to *somewhat over one per cent. A further* examination of cotton wax has revealed the presence of what appears to be another definite compound which differs in solubility, melting point, and composition from that described by Schunck.

GENERAL NOTES.

Abstract of evidence given before the Therm Charges Committee by the Assistant Secretary of the Institute of Chemistry (Mr. G. S. W. Marlow, B.Sc., F.I.C.), on behalf of the Council of the Institute of Chemistry and of the Board of the Institute of Physics:

The Assistant Secretary gave evidence in support of a memorandum presented by the Councils of both Institutes, which urged the authorities concerned to require that the qualifications of gas examiners should be defined, and suggested (in brief), (a) that evidence of attainment should be the possession of Fellowship or Associateship of one of the Institutes, of a University degree or equivalent diploma in chemistry and physics, or an engineering diploma with evidence of adequate training in those subjects; (b) that examiners should have had training and experience in gas examination; (c) that examiners should be members of a reputable body of chemists, engineers, or physicists.

He emphasised the importance in the public interests of the provision in the Gas Regulation Act as to the competence and impartiality of the gas examiners. He pointed out, however, that there was no provision in the Act for a definition of competence and impartiality, and that gas examiners were appointed by local authorities who, in many cases, were not compe-

tent to judge of the qualifications required of gas examiners. He then related the endeavours the Institute of Chemistry had made in 1920, whilst the Bill was before the House of Commons, to ensure the insertion into the Act of such definition, and related further that the Institute had been unsuccessful even in persuading the Board of Trade to give an indication of the nature of the qualifications required.

He referred to the fact that the Gas Referees, who had power only to advise, had issued a memorandum for the information of local authorities, in which some guidance as to competence and impartiality had been given, but he remarked that this memorandum contained phrases which lacked definition, and therefore the Institutes of Chemistry and of Physics had endeavoured to provide the necessary definition.

He then reviewed some of the appointments which had already been made, with a view to showing that local authorities had in some cases made unsuitable appointments. With regard to the appointment of whole-time officers of the authorities (such as medical officers of health, inspectors of weights and measures) he suggested that it was undesirable in the public interests that an officer should be appointed who *prima facie* was not competent, even though personally he might possess qualifications which might be deemed sufficient, since the psychological effect, upon the public, of indubitable evidence of competence was important. Moreover, such persons could not be considered impartial since in cases of doubt they would be biassed towards giving a satisfactory report in view of the fact that failure to maintain an adverse report might possibly endanger their major appointments.

He also criticised cases in which local authorities had advertised appointments to tender, and suggested that persons of good professional standing would be unlikely to apply under such conditions.

In further criticism of certain aspects of the Act, he suggested that it was not in accordance with the public interests that the gas examiners should be required in certain cases to give notice to the gas companies of the time at which they proposed to make a test, and further that for the good administration of the Act, it was desirable that provision should be made for separate "lock-up" testing stations, so that there might be no doubt as to whether instruments had been tampered with.

In conclusion, he drew particular attention to the desirability of gas examiners being members of reputable professional bodies which had strict rules of professional conduct, and could exercise penal powers upon examiners who mere guilty of partiality.

In reply to members of the Committee, the Assistant Secretary remarked that in order that provision might be made for such regulations as to competency, the Act would require amendment, and he suggested that the Board of Trade or the Gas Referees should be given powers similar to those possessed, say, by the Ministry of Health, in the case of public analysts under the Sale of Foods and Drugs Act, to prescribe regulations as to competency.

He agreed that it would be possible to arrange for the *ad hoc* examination of candidates for posts as gas examiners, such examinatio nto be conducted under the auspices of the Institutes, or alternatively to provide for the recognition of existing examinations.

In the subsequent evidence of witnesses, particularly that of Mr. Butterfield, a Gas Referee, it was clear that the Committee had grasped the importance of the question of the competency and impartiality of the examiners, and also of the other matters mentioned in evidence.

The Chairman of the Committee remarked to Mr. Butterfield that the very wide powers given to the Gas Referees appeared to be rendered void in certain cases, since there was nobody who had a power of veto upon the appointment of incompetent examiners.

TO LIGHT A TOWN OF 100,000 INHABITANTS.

B.E.A.M.A.'s £130,000 Offer of Power Station and Plant at Wembley.

From one source alone, enough electric power to light a town of 100,000 inhabitants will be supplied to the British Empire Exhibition at Wembley.

We are officially informed that the Council of the British Electrical and Allied Manufacturers' Association have offered to supply to the Exhibition a temporary power station, the value of the plant for which amounts to about £130,000. The turbine station will be complete with switchboards and sub-stations. They are

also prepared to supply additional generating plant, if required, amounting in value to over £50,000. This plant will be lent to the Exhibition on terms representing only a small fraction of its value.

The power generated in this station would supply a town of 100,000 inhabitants, or it would light a 60-watt lamp every hundred yards on the road from London to Glasgow.

The blades of the turbines will revolve at a speed of five miles a minute. While the exhibition is open they will travel a distance which would enable the world to be traversed and every dominion in the Empire to be visited no fewer than twenty times; while those more venturesome than Jules Verne could travel to the moon and back.

Enough steam will be evaporated in the power station to flood the stadium to such an extent that the cup finalists would have to play the game up to their knees in water.

Coal to be consumed, if brought in one load, would require a train over two miles long.

UNIVERSITY OF PRAGUE.

An interesting ceremony took place on January 8, 1923, at the Promotion Hall of the Bohemian (Charles) University, when the degree of Doctor of Natural Science was conferred by Professor J. Šterba-Böhm upon Mr. J. G. F. Druce, M.Sc., of London.

Mr. Druce had presented a Thesis entitled, "Contributions to the Chemistry of Organic Tin Compounds." This was accepted, and Mr. Druce was called to the "rigorosum" and was examined in General, Physical, and Inorganic Chemistry and in Botany, the examinations being conducted in English and French.

Mr. Druce satisfied the examiners, and passed with distinction, and thus has the honour to be the first Englishman to obtain this degree.

In his speech acknowledging the honour conferred upon him, Mr. Druce referred to the achievements of Bohemian scientists, mentioning the researches of Professor B. Brauner upon Atomic Weight determinations and other important investigations in Inorganic Chemistry. He hoped that other English students would visit the Bohemian University, and that Czech students would visit the Universities of England. In this way the scientists of both countries would in future benefit by this exchange. The Rector of the University (Professor Horaček) and the Dean of the Faculty of Science (Professor Domin) expressed similar sentiments and hopes.

HYDROXY STEARIC ACID.

By L. G. Radcliffe and W. Gibson.

Hydroxy stearic acid is the product formed when oleic acid is sulphonated, and by appropriate treatment including recrystallisation from alcohol, the acid is obtained as crystals M.P. 81°-82° C. Both methyl and ethyl esters can be prepared by treating the hydroxystearic with the necessary alcohol (pure) and dry hydrogen chloride. Methyl ester M.P. 46° C. and ethyl ester 48.5° C. On acetylation, the acid gives a white powder, M.P. 31-32° C. Attempts to prepare a nitro derivative of stearic acid by treating bromo-stearic acid with silver nitrate in alcoholic solution were unsuccessful. Direct nitration of hydroxystearic acid gave a greenish yellow crystalline product, M.P. 83-83.5° C., and containing no nitrogen. No formula can be suggested for this unknown acid. Other nitration products are a yellow oil and a white crystalline solid, M.P. 80-120° C.—(*J. Soc. Dyers Col.*, 1923, p. 4.)

REVIEWS ON

Carotinoids and Related Pigments.

Year-Book of Pharmacy, 1922.

Dictionary of Applied Chemistry.

By John Missenden.

Cartinoids and Related Pigments: The Chromolipoids, *by* Leroy S. Palmer, Ph.D. Pp. 316. New York: The Chemical Catalog Co. Inc., 19, East 24th Street. Price $4.50.

This interesting treatise does not, as do so many volumes of a similar order, deal solely with the phytochemical aspects of the yellow-to-red colours, but also incorporates the carotinoids obtained from or contained in the vertebrates or invertebrates. The author has wisely followed M. Towett's suggested form of classification, thereby maintaining a consistency well in keeping with a difficult series of compounds. Towett divided the carotinoids

into two categories; the carotins (*i.e.*, substances identical or isomeric with carotin, $C_{40}H_{56}$*), and the xanthophylls (*i.e.*, substances chemically related to carotin).

Extensive lists showing the organic origins of the carotins and xanthophylls have been introduced, as well as a list demonstrating the sources of both in the same plant or tissue. They are very exhaustive, and improvements upon them are scarcely possible. Considerable attention has also been paid to the comparison between the flower xanthophylls and those contained in the yolks of eggs and the blood-serum of fowls; and Schunk's spectroscopic investigations have been specially quoted. Spectrophotographs illustrating the wavelengths of absorption bands of both carotin and xanthophyll in various solvents have been reproduced. At the end of the volume are comprehensive indices showing authorities mentioned and subjects dealt with.

There is one great fault with the work: it is insufficiently classified. Reference is difficult, and the general arrangement would, perhaps, prove slightly monotonous to the student. It is very exhaustive, however, and the reasoning is clear and sound. Above all, records of research are strictly up-to-date, references having been made to studies as late as last year; for example, Hashimato's "Carotinoid pigmentation of the skin resulting from a vegetarian diet" (*Journ. Amer. Med. Assoc.*, LXXVIII., 1111). As a complete review of all that is at present known of the carotinoids, no better treatise could be compiled, and it is to be hoped that the author will endeavour to facilitate reference through the text in future editions.

J.M.

* *Willstätter and Mieg.*

Year-Book of Pharmacy and Transactions of the British Pharmaceutical Conference, 1922. London: J. & A. Churchill, 7, Great Marlborough Street, W.C. Price 12s. 6d.

This book has again been produced, and again it brings up to date investigations made during a year in pharmacy and chemistry. The three editors, J. O. Braithewaite (Abstracts from Papers), Thos. Stephenson, F.R.S.E. (New Remedies), and C. H. Hampshire, B.Sc., F.I.C., are to be congratulated upon the discriminative care they have exercised in their respective compilations.

Copious revisionary notes have been added to the abstracts, and cover every branch of the year's research that has passed the cognisance of the Society. Special recognition is due to the numerous suggestions contained in the dispensing section, emphasis having been laid upon the rendering of precipitates easily diffusible. Among the papers read during the course of the conference are included three of inestimable importance, "Some Characteristics of Wheat-Starch," by T. E. Wallis, B.Sc. (Lond.), F.I.C.; "A Simple Instrument for taking Refractive Indices of Liquids," by R. Fouracre, Ph.C., F.S.M.C.; and "The Extraction of Quinine and Strychnine from Solutions of varying Hydrogen Ion Concentration: A Method for the Separation of Strychnine from Quinine," by Norman Evers, B.Sc., F.I.C.

The annual report showed an increase in membership for the Society, and a scheme was recommended for Committee reorganisation. The book not only shows itself invaluable and indispensable to existing members, but should certainly be on the bookshelf of every enterprising pharmacologist.

J.M.

A Dictionary of Applied Chemistry, Vol. IV., by Sir Edward Thorpe, C.B., LL.D., F.R.S. Pp. VIII. + 740. London: Longmans, Green & Co., 39, Paternoster Row, E.C.4. 1922. Price £3.

This volume covers the ground between L-acid and Oxydisilin, and incorporates the results of later research in every branch of Chemistry in this section. Many prominent chemists have contributed to it, each one an authority upon his particular subject.

Specific attention has been paid to substances of wide commercial utility and of pharmacological urgency. This is quite notable, as, in the construction of a work of this description, such a broad outline is seldom attained.

Two interesting papers, one upon Matches and the other upon Leather, typify the tone of the work. These papers not only give data solely from a theoretical standpoint, but also treat at some length with the practical sides. Extensiveness has been accorded such subjects as the Lactones, Logwood, Metallography, Methyl, the Naphthalenes, Essential Oils, and Opium. This is but a cursory selection, and a number of others, well worthy of eulogistic mention, could be quoted.

Even as a separate factor, the volume is admirable; but as one of a series, it is ex-

emplary. Considering, too, the excellence of the information it contains, its price is most reasonable, and in no way to be regarded as a bad investment by those who require a complete survey of every by-way in Chemistry. J.M.

NOTICES OF BOOKS.

Text Book of Inorganic Chemistry, by Dr. J. Newton Friend, D.Sc., Ph.D., F.I.C., Carnegie Gold Medallist. Pp. XXV. + 367. Second Edition, volume IX., Part I. London: Messrs. Charles Griffin & Co., Ltd., Exeter Street, Strand. 1922. Price 18s.

It is gratifying to find that a second edition of such a book of reference as this by Dr. Friend has been called for. It indicates that this series of text books supplies a real need.

Most of the few errors that crept into the first edition have been corrected, and a summary of the dates of issue of the more important journals has been introduced.

It may be noted that the equation given on page 233 for the preparation of Osmium cyanide, does not balance.

Among the many and useful tables given is the number of nickel coins cast in various countries. The information contained therein may be trustworthy, but it would be interesting to know who is responsible for giving the currency of U.S.A., as paras and centisimos!

This volume, together with the others in the series, will be widely consulted and used by students and also by experienced workers.

Bleaching Powder and its Action in Bleaching, by R. L. Taylor, F.I.C. Pp. 79. Manchester and London: John Heywood, Ltd. 1922. Price 4s. 6d.

Mr. Taylor's book has been based upon his contributions to the theory and practice of Bleaching, since 1910. These are reproduced almost in the form in which they originally appeared, in chronological order, and include the author's important investigations on other action of carbon dioxide and of dilute acids on bleaching powder and on hypochloric acid, and on other branches of the subject as well.

It will be a convenience for students and others to have this information in a permanent form.

New Patents.

This list is specially compiled for the *Chemical News, by Messrs. Rayner & Co., Registered Patent* Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

43—Bader, T.—Treatment of cellulose-acetate products. Jan. 1.

78—Metals Production, Ltd.—Leaching copper ores containing slimes. Jan. 1.

478—Nicholson, W. E.—Manufacture of sulphuric acid. Jan. 5.

Specifications Published this Week.

190553—Dunstan, A. E., Remfry, F.G.P.—Treatment of petroleum and other liquid hydrocarbons.

169725—Wendel et Cie Les Petits Fils De F. De.—Receptables for the transportation and preservation of air or other gases in the liquefied state.

174595—Akt-Ges Fur Anilin Fabrikation.—Process dyeing skins, hairs, and the like.

190698—Jacobson, B. H.—Manufacture of anhydrous metal chlorides.

Abstract Published this Week.

Organic Mercury Compounds. — Patent No. 188376.—Messrs. Fahlberg-List & Co., of 57, Alt Salbke, Sudost, Magdeburg, Prussia, Germany, have evolved a new process for the production of aromatic mercury cyanide compounds.

They are prepared by treating complex mercury compounds of phenol and its homologues with alkali cyanides in aqueous solution, or by heating phenol and its homologues with mercury cyanide in alkaline solution or with mercuric oxide in alkali cyanide solution. The products are efficacious against plant diseases. According to examples (1) mercury cresol cyanide is obtained by dissolving mercuric oxide in dilute sulphuric acid, adding o-cresol, boiling the resulting precipitate with sodium cyanide solution and evaporating the filtrate in vacuo; (2) o-cresol is boiled with mercury cyanide and dilute sodium hydroxide, and the mercury cresol cyanide separated by carbon dioxide or dilute acids; (3) mercury phenol cyanide is prepared by boiling phenol with mercuric oxide in sodium cyanide solution and treating the cooled solution with carbon dioxide or dilute acids.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3278

THE ISOLATION OF THE OXIDE OF THE NEW ELEMENT.

At the meeting of the Chemical Society on February 1, 1923, Dr. Alexander Scott delivered a paper on "A New Element belonging to the Fourth Group of the Periodic System." Its oxide resembled those of Titanium and Zirconium.

He had discovered it in a black sand from New Zealand, where large quantities may be obtained. Upon analysis, Dr. Scott found that this sand gave a residue insoluble in sodium hydrate. The residue was partially attacked by sodium bisulphate.

By this treatment about 1.4 grams of a solid resembling titanium dioxide were obtained. It was difficult, however, to discover a method for the determination of the equivalent of the metal which did not form salts readily.

It was eventually converted into the double potassium fluoride by treatment with potassium carbonate and hydrofluoric acid.

Dr. Scott announced that during the day (February 1) he had completed two analyses of this double fluoride.

He found that 0.7203 gram of the salt, K_2XF_6, gave 0.4507 gram of the oxide, XO_2. This result, the sum of two determinations, indicated that the element had an atomic weight of 175, corresponding with an atomic number of 72.

The element is thus identical with that announced by D. Coster and G. von Hevesy from the results of their examination of the spectra of certain zirconium ores.

Its oxide, XO_2, which was exhibited with specimens of the sand, was cinnamon brown in colour, which Dr. Scott stated might be due to a very minute trace of ferric oxide. He said that whilst the investigators in Denmark had only observed the spectrum of what they termed Hafnium, he had actually a quantity of the oxide.

Sir William Tilden, F.R.S., who presided, stated that Dr. Scott's discovery was a very remarkable one. It was, perhaps, noteworthy that few discoveries of new elements had been communicated to the Chemical Society. Thus when Sir William Crookes discovered thallium in 1862, he naturally announced his discovery in *The Chemical News*.

Prof. H. E. Armstrong, who also rose to congratulate Dr. Scott upon his great achievement, hoped that a more appropriate name could be given to it. It was a difficult question to settle the point as to who had actually discovered the new element. It had developed from the application of Moseley's method, whereby we knew there was a blank at the position 72.

Prof. Smithells, who conveyed the congratulations of the country Fellows to Dr. Scott, pointed out that this was the first case of the discovery of an element which had actually been looked for and found.

At the same meeting of the Chemical Society, two other papers were read: "The Derivatives of Tetrahydrocarbazole," Part II., by W. H. Perkin and S. G. P. Plant, and "The Chemistry of Polycyclic Structures in relation to their Homocyclic Unsaturated Isomerides," Part IV., by C. K. Ingold, E. A. Seeley, and J. F. Thorpe.

A NATIONAL ASSET.

THE ROMANCE OF A WAR WINNING INDUSTRY.

By Colonel Sir Arthur Holbrook, M.P.

Gas has proved such a useful servant to the general public that the present seems an opportune time to state a few facts which stand to the credit of the much maligned gas undertakings. Eleven years ago, the centenary of gas as an illuminant was celebrated, and during the whole of that period its history was one of progress from public want to public want. Previous to that our harder living forebears had been more or less content with hard-won sparks from the chafing of flint and steel for the lighting of rush-lights and candles. The clergy of many churches preached against the introduction of gas into churches as "profane and contrary to God's laws."

But gas lived down all this opposition and became what it is to-day, an indispensable adjunct to our very existence. And the reason for this lies on the surface: the needs of the community have been studied by the great industry. During the whole period of more than a century's service to the public, the best brains of the industry

have been engaged on improving methods *of supply and cheapening costs.*

Modern science has revolutionised the gas industry out of all recognition, and in doing so has, to a large extent, revolutionised the homes of the people by adding to their comfort, cleanliness, and convenience. Few people appreciate the national value of the 1,600 gas undertakings. The country has, perhaps, no greater asset. Time was when the carbonisation of coal was carried out with only one objective—production of ags. *To-day there is hardly any trade or* manufacture in which is not used some substance or another produced by the distillation of coal at the gas works.

Precisely how vital and how necessary the gas undertakings of this country are was demonstrated during the war, and it can be truthfully said that no industry *more than the gas industry helped to win* the war. The products of gas works and gas ovens saved the Allies. This assistance took the form of the production of such necessary products as benzol and toluol for the manufacture of high explosives, dyes and motor spirit, sulphate of ammonia, creosote, tar, and carbolic. During the war *one gas undertaking alone supplied enough* T.N.T. material for the manufacture of lyddite and other explosives to fill 160,000,000 18-pounder shells, 17,000,000 gallons of oil, and 13,000 tons of disinfectants. The total for the whole industry ran into figures representing six times these gigantic totals.

And gas has its uses in peace no less than in war, altogether apart from its domestic utility. Germany built up her great dye industry by working up the by-products largely obtained from England, and the dyes resulting from these by-products were purchased by the rest of the world from Germany, who reaped a rich annual harvest of many millions.

If England's dye industry and chemical trades are to be kept in existence, the gas industry must flourish. Out of smaller services rendered to the State, many other industries have reached the peak of prosperity. Not so the British gas undertakings, which were seriously handicapped *during the war and have had tardy help* since to recover their lost ground.

But few people realise how closely coal distillation is bound up with food production. Vegetables cannot live without a proper supply of nitrogen, and before the war this country imported large quantities of nitrate of soda for this and other purposes. This supply was cut off during the war, so the gas works produced increased quantities of sulphate of ammonia, which serves the same useful purpose. Without this sulphate, grass and grain fields would yield but very poor results, and that would mean much less meat and corn for consumption.

Allotment holders are indebted to gas works for the gas lime which is so detrimental to the destructive wire-worms. Then *there is naphthalene, which proved a God-*send to the men at the front by helping them to exterminate lice and other vermin. And when "Tommy" went into hospital there came to his aid the products of the gas works in the shape of aspirin, phenacetin, and antipyrine, for all of which coal-tar from the gas works is responsible. *Other friends in every-day life which emanate* from the gas works include sulphonal for sleeping purposes, sal-volatile, carbolic acid, lysol, and such like useful things.

And so the wonderful story of a thousand and one uses of gas and gas products goes on. It is a worthy record, and the end is not yet, for the industry is always striving *to keep abreast with modern requirements,* and to raise the standard of efficiency. The gas indusrty did not fail the nation during the war, and will not fail the nation in the piping times of peace. Given fair play—it asks no favour—its history, as of old, will be one of progress from public want to public want.

EMPIRE'S RESOURCES IN THE LESS COMMON METALS.

Professor G. T. Morgan, head of the Chemical Department of the University of Birmingham, is the President of the Chemical Society of that University, and on Monday, January 22, he delivered his Presidential address on "The Empire's Resources in the Less Common Metals." The attendance, which numbered over 200, included many industrial chemists of Birmingham and the Midlands.

The author observed that in his Presidential address of last year he placed before the Society a survey of the post-war problems affecting the synthetic colour industry. The chief reason why this branch of chemical enterprise has become a so-called "key" industry is, in his opinion, an

educational one. A highly developed industry in coal tar products leads with unfailing certainty to proficiency in other chemical arts. The inter-dependence of all branches of chemical trade has been demonstrated up to the hilt by the development of chemical industry in Germany, a country where faith in the possibilities of chemical development is far more generally accepted than in any other civilised nation.

The great Rhenish firms are something more than commercial undertakings, they are technological universities of the highest grade. It is largely owing to the educational leaven of these scientifically directed enterprises that Germany has gained her supremacy and prosperity in the main branches of chemical industry. The utilisation of atmospheric nitrogen, many modern metallurgical processes, scientific glassware, synthetic rubber and the highly profitable trades in drugs, photographic chemicals, synthetic tanning materials, artificial resins, synthetic essences and other fine chemicals have arisen as offshoots of the scientific industry in coal tar dye wares. These colour factories afford a training to the chemist and chemical engineer which at present is hardly to be obtained in any other country or in any other branch of industry.

In short, the main thesis which should be pressed on the attention of all our public men and leaders of industry is that in regard to the safeguarding of our natural resources in *materia chemica* there is only one strategic chemical front, and we cannot fall behind in any particular branch of chemical trade without grave risks of losing ground in all the correlated industries.

Owing to the wide geographical distribution of the community of nations known as the British Empire, these countries exhibit within their boundaries striking diversities of geological structure with a varied assortment of mineral deposits. The exploitation of these mineral resources, so far as it has progressed, shows that the British Empire has a very generous endowment of the common and precious metals. The possession of this mineral wealth involves us, however, in the grave responsibility of utilising these hidden treasures to the best advantage. We must give a faithful account of our stewardship, otherwise sooner or later the task will be undertaken by others.

A comprehensive study of inorganic or mineral chemistry shows us that each elementary type of matter is possessed of certain characteristic and unique properties which are not shared completely by another element, even when the two are closely related. Consequently the industrial employment of any element resolves itself ultimately into finding a use for one or more of its unique properties. The utilisation of such rare elements as neon, thorium and vanadium encourages the belief that ultimately some employment will be discovered for all the elements either free or in a state of combination.

Professor Morgan referred to the Empire's resources in the precious metals, gold and silver, and also to the light metals, aluminium, magnesium and beryllium, which are of special interest in the production of light alloys. Ultra-light alloys are now being produced by the Magnesium Co., Ltd., of Wolverhampton. The metals of the less common earths are utilised chiefly in the form of their compounds. Barium and strontium preparations are largely derived from British sources, and the world's requirements for thoria and ceria employed in the incandescent mantle industry, are largely supplied from the extensive Travancore deposits which will meet the demand for many years.

The favourable situation of the Empire in regard to the supply of tungsten minerals should place us in a premier position for manufacturing tungsten steel, but nevertheless, before the war, Germany controlled two-thirds of this production, the importation of German tungsten into this country having an annual value of £300,000. This unfavourable position, which existed up to July, 1915, was a contributory cause of the shortage of shell which jeopardised the military operations in the late war. He regarded the production of tungsten steel as one of the great triumphs of modern metallurgy. In the development of our mineral resources it is essential to take the long view. Systematic research is needed, even on chemical elements which have not hitherto received industrial application. Zirconium was cited as an instance of a metal which has so far been examined chiefly by German and American chemists, the English contribution to this branch of mineral chemistry being comparatively small. Cobalt is another example of a metal which merits increased attention, the annual production

being only of the order of 400 tons. The chief deposits are in Ontario, and Canadian chemists are becoming prominent as investigators of this element. Cobalt is a metal with a future, coming into use now as an alloy metal instead of being restricted, as it was until recently, to employment in combination as a pigment colouring material. Cobalt confers hardness and durability on aluminium. There is a world famine in regard to the valuable metals of the platinum group, owing to the partial failure of the Russian supply. These metals have been detected in many parts of the British Empire. Tasmania has furnished osmium and iridium, whereas the Sudbury nickel-copper ores of Ontario have yielded notable quantities of platinum and palladium.

Referring to magnesium, he pointed out that the metal, which has exceptional lightness, is permanent under ordinary atmospheric conditions, especially when free from impurities. Minute quantities of such foreign substances as alkalis or chlorides cause local granular corrosion. The metallurgy of magnesium depends on electrolytic processes, and considerable progress in this isolation has been made in the United States. The sudden drop in the number of producers and in the output is due to the competition of the German product. Germany controls a large portion of Austrian magnesite, and owing to the depreciated currency it can sell in any market in spite of import duties.

On the subject of beryllium, Professor Morgan had something interesting to say. Owing largely to the scarcity of beryllium, minerals, comparatively little headway has been made in the isolation of beryllium, although the physical constants of this metal show that it would be a valuable aid in the production of light alloys, providing that a sufficient supply of its minerals was forthcoming.

The commonest of these minerals, beryl, is an acidic silicate of beryllium and aluminium, $3BeO, Al_2O_3, 6SiO_2$, occurring both in the old world and the new. A well known deposit exists at Limoges in France and considerable quantities have been noted in New Hampshire, where beryl crystals of enormous size up to 2½ tons occur native. Within the British Empire there is a small unexploited deposit in Glen Cullen, Co. Dublin. It is also found in the former German colony of S.W. Africa. Hitherto only small quantities of beryllium metal have been produced. The first difficulty encountered in the metallurgy of beryllium is the separation of beryllium from alumina.

Beryl is an acidic felspar like orthoclase, and accordingly it is not appreciably attacked by the common mineral acids, hydrochloric, nitric and sulphuric acids. It is opened up, however, by fusion with caustic alkali, this reagent forming alkali silicate and yielding a mixture of alumina and beryllium carbonate. Subsequent treatment with dilute sulphuric acid precipitates silica. The filtrate contains beryllium and aluminium sulphate, and if the alkali used in the fusion contained potash, a good deal of aluminium sulphate crystallises in the form of potash alum and is thus separated. The beryllium remaining in solution as the more soluble sulphate is separated partially from the remaining aluminium by taking advantage of its solubility in ammonium carbonate, this reagent precipitating aluminium hydroxide. By diluting and boiling the solution, hydrated beryllia is precipitated and subsequently converted into the basic acetate, $Be_4O(CH_3.CO_2)_6$, a co-ordination compound of considerable stability which, although only sparingly soluble in water, has the remarkable property of dissolving in such organic solvents as acetone, chloroform, benzene, etc. This beryllium derivative has a definite melting point, and when pure can be sublimed without decomposition. These singular characteristics render it useful in the final separation of beryllia from alumina.

Two other processes have been tried with good results, in Birmingham, by Mr. T. J. Hedley. These methods are based on the use of fluorides. In one process beryl is heated with hydrogen fluoride and ammonium fluoride until the silicon is volatilised and the residue contains the fluorides of beryllium, aluminium and iron. The second procedure, a French process, which obviates the use of poisonous hydrofluoric acid, consists in heating the finally powdered mineral with sodium silicofluoride. The product, on lixiviation with water, gives a solution containing sodium beryllium fluoride only, the other constituents remaining as sparingly soluble products. Whatever process was employed, it was found that the final purification is best effected through the basic acetate.

We are still only on the threshold of the metallurgy of beryllium. The purified acetate must be converted into oxide and and fluoride when, by an electrolytic process akin to that employed for aluminium, the metallic beryllium is isolated. Even a moderate supply of beryllium or its alloys with copper and other metals would be an aid in aeroplane and airship construction. Beryllium, although a rare metal, is well worthy of the serious consideration of chemists and metallurgists.

Aluminium is the only fairly plentiful metal of the light metal group; some of the others, such as scandium, gallium, indium and thallium being excessively rare. Yttrium and lanthanum belong to the metals of the rare earths, comprising some 18 elements, of which certainly two have met with industrial application. These are thorium and cerium, both of which are derived from the mineral monazite, a phosphate containing several other metals of the rare earth series.

Having regard to the world's production in recent years, we should be in a premier position in regard to the production of incandescent mantles, the manufacture of which utilises the thoria and a small proportion of the ceria. Until the war, however, the manufacture of these mantles was largely a German and Austrian monopoly. The Travancore deposits were entirely in the hands of German agents, and all the mineral obtained was exported from India to Germany. During the war these enemy interests were eliminated and the industry placed on a satisfactory basis under control of British capital. These Travancore deposits are very extensive. They are the chief source of thoria, and will suffice to meet the world's requirements for many years. As by-products from the monazite concentrates, ilmenite (ferrous titanate) and zircon (zirconium silicate) are obtained. Both are separated from monazite by electromagnetic treatment. These by-products, which contain respectively titanium and zirconium, may come to have an economic value. The monazite exported from India in 1918 was 2,117 tons, valued at £58,820.

Although Germany is now obliged to purchase monazite from external sources, her activities in these markets show that the trade in thorium nitrate and incandescent mantles is very prosperous. During 1921 the output of incandescent mantles in Germany was 2,000,000 gross. The imports of incandescent mantles from Germany into England in 1291 were 63,756 gross, or nearly three times the 21,359 gross imported in 1920. The value of the larger import was £111,917. In 1922, evidence given before the Committee appointed under Part 2 of the Safeguarding of Industries Act showed that of four thorium nitrate factories in the United Kingdom three were closed and one was working half time. The sales in Great Britain of British made incandescent mantles was 444,000 gross in 1920, but only 280,000 gross in 1921. A certain degree of support is afforded to the British industry under the Safeguarding of Industries Act, but a repeal of this measure would expose the newly created industry to the full force of German competition. This adverse factor is effective largely because of the depreciated value of German currency and the great difference between the internal and external value of the mark.

Titanium in the form of its oxide (rutile), or as the ferrous compound, ilmenite, FeO,TiO_2, is widely diffused, and is among the more plentiful elements of the earth's crust. There is as yet no commercial method for producing elemental titanium. Difficulties arise owing to the chemical activity of the element and its high melting point (about 1,800° C.). The most important use of titanium lies in the production of ferrotitanium alloys. There are two of these, one containing carbon (0.8 per cent.) and the other free from this element. They contain respectively 15 and 25 per cent. of titanium. These alloys are used as deoxidizers, oxygen and nitrogen scavengers, and not as alloying materials. About 0.1 per cent. of titanium in the form of the Fe-C-Ti alloy is added to the steel as the last addition before pouring, and ten minutes are allowed to complete the action of the titanium.

Before the war there were 15 manufacturers of titanium alloys in Germany, 3 in Great Britain, 2 in France, and several in Sweden and Switzerland. Titania, TiO_2, is used in pigments; titanium white (TiO_2 25% + $BaSO_4$ 75%). A good workable glass may contain titania replacing silica. A batch is given as containing

SiO_2	24-69 parts	Na_2CO_3	29 parts.
TiO_2	15-45 ,,	Lime	7 ,,
Borax	10 ,,		

Titania was utilised long before the war as an alternative refractory material to silica in the construction of crucibles. Like silica, it withstands sudden changes of

temperature without fracture, and being less basic it is less readily corroded by the basic metallic oxides used in gravimetric analysis.

Zirconium and its compounds are a worthy subject of chemical research.

Zirconia, which has a high melting point and low conductivity for heat, possesses a low coefficient of expansion, and withstands sudden changes of temperature. It is inactive towards most chemicals, and is scarcely attacked by strong acids, alkaline fusion mixture, or the ordinary fluxes and slags.

These properties point to the value of zirconia as a refractory material. It has been employed in making crucibles, muffles and combustion tubes which are gas-tight up to 1,000°. Zirconia crucibles have been used to melt pure iron, platinum, and tungsten alloys. Zirconia linings for the hearths of steel furnaces are very durable. It is also used to produce opacity in glasses and glazes. In medicine it has been substituted for bismuth nitrate as a means of taking X-ray observations of the alimentary canal.

In this connection, Professor Morgan mentioned that two Danish chemists claimed to have discovered a new element in the zirconium minerals.*

The Professor thought he had said sufficient to show that there was sufficient work to be done by all chemical students from the Birmingham and other English Universities. They cordially welcomed among them Mr. Pilcher, of the Institute of Chemistry, who is a good friend of chemists, and has done much to diminish unemployment among chemical graduates.

"Although chemical industry is temporarily under a cloud for various reasons," he added, "the outlook is not bad for the adequately trained chemist."

* *Dr. A. Scott has also announced the isolation of an oxide of a new element from a similar source.*

NOTES ON THE ACTIVE PRINCIPLES OF SOME SOUTH AFRICAN PLANTS.

By Charles F. Juritz, M.A., D.Sc., F.R.S.S.Af., F.I.C., Chief of Division of Chemistry, Department of Agriculture, Union of South Africa.

(*Continued from Page* 70.)

III.—Mafeura bean (Trichilia emetica Vahl):

This constitutes the seed of the Cape Mahogany (Dutch-*Essenhout*; Kaffir-*um-Kuhlu*), one of the most magnificent ever-green trees in the forests of Pondoland, growing to a height of 80 feet, with a leafy canopy some 50 feet in diameter. The seed of this tree has of late years acquired some importance as a source of oil for soap making, and attempts have been made to utilise the cake after expression of the oil in a manner similar to that adopted for other oil cakes; that is to say, both for feeding purposes and as a fertiliser. The following analyses of this cake have been made in the laboratories of the Division of Chemistry, No. 1 at Cape Town, Nos. 2, 3 and 4 at Pretoria:

	No. 1.	No. 2	No. 3.	No. 4.
Moisture	11.98			
Ash	14.14			
Protein	22.93			
Oil	10.91	17.12	25.36	29.79
Fibre	9.66			
Nitrogen-free extract	30.38			
Nitrogen	3.67	3.93	3.51	3.00
Phosphoric oxide	1.11	1.17	0.63	0.57
Potash	1.84	2.79	2.19	2.14

From a fertilising point of view the article is not of very high grade, but it may be worth applying to hungry soils, poor in humus, and therefore, incidentally lacking in nitrogen. As a fertiliser it would not be profitable to transport it any distance, and it, moreover, possesses certain defects as a fertiliser inherent in its high oil content.

The poisonous nature of the seed is not as definitely settled as it might be. Dr. Marloth observed[16] regarding the genus *Trichilia*, "The seeds contain much oil: that of *T. emetica* is edible, while the oil of *T. Dregei* is employed by the natives only for greasing their bodies." Of course, it is quite possible that the *oil* may be edible while other constituents of the bean may be poisonous. Dr. Marchand, in his article on "Fertilisers" in the July, 1918, issue of the *South African Journal of Industries*, remarks that "the cake left after the expression of the oil is useless as a stock food, as it contains a poisonous principle," and he quotes an investigation by Mr. J. S. Jamieson, F.I.C., on the subject.[17] But Mr. Jamieson undertook the investigation *not of the entire seed, but only of the bark* and seed-oil of *T. emetica* (because the Rev. A. T. Bryant had described that bark as very poisonous), and stated in his opening paragraph that the "absence of toxic symptoms on administering it to guinea pigs upholds the view that it is not poisonous." Mr. Jamieson also states that he mixed about 10 grams of the *fat from the* seeds with mealie meal and administered it to a guinea pig with no toxic effect or symptoms. "The bark of T. emetica," he says, "which is known to the Natal Kaffir as the *um-Khulu*, is used as a purgative medicine." From the bark he extracted a rather refractory resin, to the large proportions of which he ascribed the purgative action of the bark. Mr. Jamieson's paper contains nothing whatever to warrant the inference that the seed either before or after extraction of the oil is in any way poisonous. On the other hand, I am informed by Mr. L. H. Hyman that the results of numerous experiments show the cake from *undecorticated* seeds to be extremely toxic, and to cause death invariably when fed to guinea pigs. Natives, he tells me, consume large quantities of the *decorticated* kernel without any apparent harmful effect.

The Rev. A. T. Bryant, in his paper on Zulu medicine and medicine men,[18] includes *um-Khulu* (*T. emetica*) in a list of plants, of which he says "all of the following should be labelled at any rate as dangerous, *many of them being most certainly fatally* poisonous, and that, with some constitutions, even in minute quantities." "It must be recollected, however," he adds, "that every part of a plant is not always equally poisonous; that the noxious properties are not at all seasons equally great, and that they *may at times be completely* removed or neutralised by the method of medicinal preparation." (p. 12). Further on, he says, "The *i-Xolo* or *um-Khulu* (*T. emetica*) is a tree possessing very powerful medicinal properties, amongst others those of a purgative. A piece of the *bark*, of the length and breadth of two fingers, is pulverised and mixed into two teacupsful of hot water as an enema, in which form this drug is usually administered." There is no reference by that author to any poisonous properties of the *seed*.

In my own paper on "South African Pharmacology,"† (†*Trans. S.A. Phil. Soc.*, Vol. XVI., p. 117) I referred to another species of *Trichilia* (*T. Dregeana* E. May). A Kaffir woman at Port St. John's died after using as an enema a decoction said to have been made from the latter plant, but the examination did not lead to any definite result.

Dr. T. R. Sim states[19] that "the seeds, which are striking objects, and may be gathered in bushels under old fruiting trees, are not eaten by birds or monkeys, and are not used, so far as I can learn, in Pondoland or Transkei," but he also quotes Oliver[20] as saying, "The oil and tallow obtained from the seeds, Dr. Kirk states, are valuable, and may be had in quantity. The oil is used in cookery."

From all the above it will be seen that the alleged poisonous character of the decorticated seed has no very definite scientific evidence to rest upon, although the shell or capsule thereof is apparently poisonous.

[16] "*The Chemistry of S.A. plants and plant products*," p. 11.

[17] *Rept. S.A. Assoc. for Adv. of Science*, 1916, p. 496.

[18] *Annals of the Natal Museum*, Vol. II., Pt. I., 1909.

[19] "*Forest Flora of Cape Colony*," 1906, p. 161.

[20] "*Flora of Tropical Africa*."

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

ORDINARY MEETING, JANUARY 25, 1923.
Sir Charles Sherrington, President, in the Chair.

The following papers were read, the summaries here printed having been supplied by the authors for use at the meeting:—

PROF. A. V. HILL, F.R.S. *The Potential Difference occurring in a Donnan Equilibrium and the Theory of Colloidal Behaviour.*

Loeb has shown experimentally that there is a potential difference between a colloidal solution of a protein and a crystalloid solution with which it is in equilibrium across a membrane, impermeable to the protein, but permeable to the other bodies involved. This P.D. varies in the same general manner as the osmotic pressure, the viscosity and the swelling, when the concentration of hydrogen ions or of salt is changed, and the manner of variation of the P.D. can be deduced, in general, from the theory of the Donnan equilibrium; hence it is concluded by Loeb that the Donnan equilibrium is the basis of the colloidal properties of protein solutions. While the probability of this conclusion is admitted, it is pointed out here that one of the chief arguments employed in its favour by Loeb is incorrect. Loeb shows that the P.D. observed experimentally agrees very exactly with that "calculated" from the difference in hydrogen ion concentration, also observed experimentally, and concludes that this supports his theory. As a matter of fact the equality he has observed is a necessary consequence of the manner in which his observations were made, and of general thermodynamical reasoning, and is independent of any theory of the mechanism by which the P.D. is produced.

E. F. ARMSTRONG, F.R.S., and T. P. HILDITCH. *A Study of Catalytic Actions at Solid Surfaces. X.—The Interaction of Carbon Monoxide and Hydrogen as conditioned by Nickel at relatively Low Temperatures. — A Practical Synthesis of Methane.*

Attempts to produce formaldehyde or methyl alcohol by passage of a mixture of carbon monoxide and hydrogen over nickel at temperatures 220-280° C. have been so far unsuccessful, but it was observed that under these conditions a mixture of equal volumes of the two gases was largely transformed into methane and carbon dioxide:

$$2CO + 2H_2 = CO_2 + CH_4.$$

This action has hitherto escaped notice, although it affords the simplest and most economical means of producing methane in quantity, since a suitable gas mixture exists in ordinary commercial water-gas when the latter has been freed from catalyst poisons by removal of sulphur compounds.

The process is available for the preparation of pure methane, or for partial conversion of the original gas mixture, yielding a gas enriched to any desired degree in methane.

The action is at first sight anomalous, because it involves simultaneous oxidation and reduction of CO under entirely reducing conditions. The experimental data obtained are so far definitely against any intermediate formation of formaldehyde or methyl alcohol, but are compatible with a combination of what is usually known as the "water-gas reaction":—

$$CO + H_2O = CO_2 + H_2,$$

with the normal hydrogenation process:—

$$CO + 3H_2 = CH_4 + H_2O.$$

Thus, of two volumes of water-gas ($2CO + 2H_2$), one molecule of carbon monoxide and a molecule of water (either moisture present in the gases or catalyst, or formed by initial normal hydrogenation of some monoxide) interact and yield a molecule each of carbon dioxide and of hydrogen, the latter, with the balance of hydrogen present in the original gas, furnishing sufficient hydrogen for the normal hydrogenation of a second molecule of carbon monoxide.

J. HOLKER, D.Sc. *The Periodic Opacity of certain Colloids in progressively increasing Concentrations of Electrolytes.* Communicated by Prof. A. V. Hill, F.R.S.

In studying the effect of electrolytes on colloids it was found that, as the concentration of the electrolyte was increased, the opacity of the crystallo-colloidal solution varied in a periodic manner.

The method of testing the effect of common salt on the typical emulsoid colloid, serum, may be described. Into each of a series of test-tubes was pipetted 0.5 cc. of undiluted serum. To each tube was then added 2 cc. of solution of sodium chloride, which progressively increased in concentration in each successive tube. The tubes were then shaken and placed in a thermostat at 40° for four hours. At the end of that time the opacity of the solution was determined by a new method.

It was shown that the periodic phenomenon is a general one. It is given by colloids of both the emulsoid and suspensoid type, and by animal, vegetable, and mineral colloids. It is also given by certain mixtures of simple aqueous solutions of inorganic salts, *e.g.*, by a "buffer" solution of phosphates to which are added progressively increasing concentrations of calcium chloride.

Emulsoid colloids tend to give many oscillations of low amplitude. Suspensoid colloids tend to give few oscillations of high amplitude.

For a given set of conditions the phenomenon tends to be more reproducible with emulsoid than with suspensoid colloids. When the degree of aggregation of a colloid is such that precipitation is imminent, reproducibility is markedly diminished.

The phenomenon is not an optical interference of the light scattered by colloidal particles, but is a definite oscillatory change in the physical condition of those particles.

E. K. RIDEAL and R. G. W. NORRISH. *The Photochemistry of Potassium Permanganate.* Part I.—*The Application of the Potentiometer to the Study of Photochemical Change.* Part II.—*On the Energetics of the Photo-decomposition of Potassium Permanganate.* Communicated by Sir William Pope, F.R.S.

The electrode potential of potassium permanganate undergoes a change (ca 0.25 volt) when illuminated with ultra-violet light from the mercury vapour lamp, and recovers slowly in the dark. This change is correlated with a photochemical decomposition of the permanganate, made apparent by the separation of a precipitate of the composition $K_2O . 2MnO_2$, and the formation of a sol of MnO_2. Illumination establishes a photochemical stationary state, KOH being simultaneously produced by the decomposition, and removed by combination with the colloidal MnO_2. This involves an alteration of the P_h of the solution, which causes the electrode potential changes. From curves obtained the decomposition was shown to be monomolecular over the range of concentrations investigated, and from them it was impossible to calculate the velocity constant by two independent methods, the values obtained being in good agreement with that obtained by direct analysis of the decomposing solution.

The decomposition of acidified permanganate under identical conditions is of zero order, the change in type of reaction being due to non-formation of colloid. The photosensitivity of mixtures of permanganate and oxalic acid is investigated, and the results embodied in a discussion of the mechanism of the decomposition of the permanganate ion. Attention is drawn to the use of the potentiometer for detecting and measuring photochemical change along the lines indicated in this paper.

The ultra-violet absorption spectrum of potassium permanganate is investigated, and the photoactive radiation shown to lie in this region. Evidence is given for considering the *Hg line at 3128 AU.* as the chief agent. The absorption of radiant energy was determined quantitatively; the result obtained is in agreement with the Einstein Law of Photochemical Equivalent, a result of special interest as the first instance of its application to solutions.

E. A. FISHER. *Some Moisture Relations of Colloids.* Part I.—*A Comparative Study of the Rates of Evaporation of Water from Wool, Sand, and Clay.* Communicated by Prof. A. Smithells, F.R.S.

A comparative study of the rates of evaporation of water, under comparable and rigidly controlled conditions, from a wool fabric, quartz sand, silty soil and heavy clay subsoil, has been carried out.

The curves obtained by plotting rates of evaporation against water contents are, in the cases dealt with, discontinuous and very different from the corresponding smooth vapour-pressure curves. Each portion of the rate curve can be expressed by a simple type of equation connecting rate of evaporation with water content. Various factors affecting the rate of evaporation are discussed in some detail.

The rate curves obtained are similar in type in the cases of wool (wholly colloidal with a cellular structure), quartz sand (wholly non-colloidal with a granular structure), silty soil (notoriously feeble in colloid properties), and heavy clay sub-soil (typically colloidal in behaviour). The conclusion is drawn that the forces holding the water are essentially similar in all four cases, and that colloid, merely as such, has no characteristic rate of evaporation curve. It is only when certain physico-chemical factors are operative, as in the case of gelatin, that the relatively simple type of evaporation curve is not followed.

The shrinkage of clay has a characteristic effect on the evaporation curve, which can be allowed for in the equation of rate. This

effect is entirely absent in wool, as in sand and silt, and it is concluded that the so-called shrinkage of wool on drying is really a deformation and not a volume shrinkage.

An attempt is made to explain the vapour-pressure relationships of wool on the basis of capillarity; the absorption of water by wool is attributed primarily to a filling up of fine pores of various shapes and sizes, and that the vapour pressures of wool-water systems are determined by the diameters of the pores that are full of water.

R. WHYTLAW-GRAY, J. B. SPEAKMAN, and J. H. P. CAMPBELL. *Smokes. Part I.—A Study of their Behaviour and a Method of Determining the Number of Particles they contain.* Communicated by Prof. A. Smithells, F.R.S.

A study has been undertaken of highly dispersed and dilute smokes, consisting of solid particles of ultra-microscopic size, with the object of discovering whether these systems present any analogy in behaviour to the solid-liquid systems of colloidal solutions.

The smokes were produced (*a*) by the arc discharge in air, (*b*) by volatilisation and condensation, (*c*) by chemical action. In each case highly dispersed systems of very minute particles could be obtained.

As a first line of attack, a method of counting with an ultra-microscope of the slit type the number of particles in a given volume has been worked out, and it has been found that, starting from the moment after dispersal, the life-history of a smoke falls into two main periods:—

(*a*) An unstable period in which the number of particles diminishes rapidly with time.

(*b*) A stable period in which the decrease in number is slow.

During the first period the increase in size is very marked, and it is shown that these changes are not due to evaporation, but to a process of aggregation, which produces complexes of different structure depending on the nature of the dispersed substance.

R. WHYTLAW-GRAY and J. B. SPEAKMAN. *Smokes.* Part II.—*A Method of Determining the Size of the Particles they contain.* Communicated by Prof. A. Smithells, F.R.S.

A filtration method has been devised which enables the concentration in weight of the suspended solid matter in these rapidly changing smokes to be determined with an accuracy of about 3 per cent.

A given volume of smoke (usually 1 litre) is filtered through small tubes containing asbestos, and the increase in weight is ascertained by means of a micro-balance sensitive to 0.0002 mgm. The process of filtration takes about five minutes. Curves have been obtained showing the variation in weight concentration of the smoke over periods of from 0 to 6 hours. Knowing the weight and the number of the particles in a given volume, the average mass of a smoke particle at different periods can be calculated and the growth followed in a quantitative manner. Assuming the density of the particle to be that of the substance in bulk, the average radius can be evaluated.

All the weight-concentration curves show an initial rise, and this fact, in conjunction with ultra-microscopic observations, renders it probable that all these clouds contain in the early stages a large number of invisible particles of a microscopic size.

R. C. RAY. *The Effect of Long Grinding on Quartz (Silver Sand).* Communicated by Dr. W. M. Travers, F.R.S.

It is found that when quartz (silver sand) is ground for a long time, the density of the ground substance is lower than the one which has not been subjected to grinding. The fall of density shows that as much as 25.7 per cent. of the material is converted from the crystalline to the vitreous condition. This value agrees fairly with that arrived at from the determination of the molecular heats of solution.

PAPERS READ ON FEBRUARY 8, 1923.

PROF. L. BAIRSTOW, F.R.S., MISS M. B. CAVE, and MISS E. D. LANG. *The Resistance of a Cylinder moving in a Viscous Fluid.*

G. I. TAYLOR, F.R.S. *The Motion of Ellipsoidal Particles in a Viscous Fluid.*

L. F. RICHARDSON. *Theory of the Measurement of Wind by shooting Spheres upward.* Communicated by Dr. G. C. Simpson, F.R.S.

Papers read in title only.

PROF. W. E. DALBY, F.R.S. *Further Researches on the Strength of Materials.*

L. C. JACKSON and PROF. H. KAMERLINGH ONNES, For. Mem. R.S. *Investigations on the Paramagnetic Sulphates at Low Temperatures.*

L. C. JACKSON and PROF. H. KAMERLINGH ONNES, For. Mem. R.S. *Investigations on the Paramagnetism of Crystals at Low Temperatures.*

ERNEST WILSON. *On the Susceptibility of feebly Magnetic Bodies as affected by Tension.* Communicated by Prof. O. W. Richardson, F.R.S.

W. D. WOMERSLEY. *The Specific Heats of Air, Steam, and Carbon Dioxide.* Communicated by Sir Dugald Clerk, F.R.S.

THE CHEMICAL SOCIETY.

BYE-LAWS RELATING TO THE ELECTION OF PRESIDENT, OFFICERS, AND COUNCIL.

V.—Of the Constitution of the Council.

The Council shall consist of the President, not more than twelve Vice-Presidents, the Treasurer and Secretaries, and eighteen Ordinary Members. They shall conduct the business of the Society and may fill any casual vacancy in their number until the next Annual General Meeting. The President, Treasurer and the Secretaries shall be termed the officers of the Society.

An election to fill vacancies shall be held annually in manner hereinafter provided, and the result of the election shall be declared at the Annual General Meeting. The retiring members shall not be eligible for re-election until after the lapse of one year.

VI.—Of the Election of the Council.

In the month of January a list shall be prepared by the Council of the vacant places in the Council which fall due to be filled at the Annual General Meeting. This list shall be read at an Ordinary Scientific Meeting in January, and shall be published in the Proceedings. The Council shall at the same time and in the same manner intimate the names of the persons whom it proposes to nominate for the offices of President, Treasurer and Secretaries, should there be a vacancy in any of these offices.

A nomination for any vacancy among the officers, Vice-Presidents or Ordinary Members of Council may be made in writing signed by at least twenty Fellows, and must be received by the Secretaries at the Society's Rooms not later than the fourteenth day of February. Every nomination must relate to one vacant place only, and must be accompanied by a signed declaration by the nominee that he is willing to accept office if elected. Nominations may be made also by the Council.

The Council shall prepare the list of nominations for the vacant places, which shall include all candidates duly nominated. This list shall be read out by the Chairman at the first Ordinary Scientific Meeting in March, and shall be thereupon publicly suspended in the Society's Rooms, and if the number of nominations does not exceed the number of vacancies, the persons nominated shall be declared duly elected at the Annual General Meeting without any vote being taken.

If more candidates are nominated than there are vacant places, the Secretaries shall post to each Fellow usually resident in the United Kingdom a ballot paper containing a list of the vacancies for which there is a contest and of the candidates nominated therefor, distinguishing those who are nominated by the Council, and stating, in the case of candidates for the places of Ordinary Members of Council, how many are to be elected who are resident within fifty miles from Charing Cross, and how many beyond that radius, and the date by which the ballot papers must be received in order to be counted.

In the event of a ballot being required, two Fellows shall be appointed scrutators at the first Ordinary Scientific Meeting in March to assist in the subsequent counting of votes. In the event of either or both of these scrutators being unable to act, it shall be in the power of the President to appoint substitutes.

On some day previous to the Annual General Meeting the votes shall be counted by the scrutators, with the assistance of one of the Secretaries, and the scrutators, together with the Secretary, shall prepare and sign a report to the Council. A statement of the votes cast for each candidate shall be presented at the Annual General Meeting, and the Chairman shall declare the names of those duly elected.

In any case of equality of votes for two or more candidates, the Council shall decide which of the candidates shall be deemed elected.

XI.—Of the Ordinary Members of Council.

The term of office of Ordinary Members of Council shall be three years. If, before the expiry of this period, an Ordinary Member has been nominated for any other position on the Council, this nomination, if accepted, shall be deemed to create an additional vacancy in the list of Ordinary Members of Council.

The Ordinary Members shall be elected in such wise that nine shall be resident within a radius of fifty miles from Charing Cross and nine beyond such radius.

XX.—Temporary Bye-Law.

These Bye-Laws shall come into force on the first day of June, 1920.

Notwithstanding anything hereinbefore to the contrary, the Council which is in office when these Bye-Laws come into force shall be deemed to be the Council of the Chemical Society until the Annual General Meeting in March, 1921. It shall be the duty of this Council to make arrangements for the election of the Council for 1921-1922 in conformity with the foregoing Bye-Laws, and the terms of office of Members of Council elected at the first annual election after these Bye-Laws come into force shall be determined as follows:—

Of the twelve Vice-Presidents, two of each class shall retire at the end of one year and two of each class at the end of two years.

Of the eighteen Ordinary Members, three of each class shall retire at the end of one year and three of each class at the end of two years.

The Council shall determine, by arrangement or by ballot, which shall be the retiring members of each class for each year.

The Annual General Meeting of the Society for the election of officers and Council, and other business, will be held on Thursday, March 22, 1923, at 4 p.m.

THE CHEMICAL SOCIETY.

Burlington House,
Piccadilly, London, W.1.

Notice is hereby given that, in accordance with the Bye-Laws, the following vacant places in the Council fall due to be filled at the Annual General Meeting of the Society on the 22nd day of March, 1923:—

President, one vacancy.

Vice-Presidents who have filled the office of President, two vacancies.

Vice-Presidents who have not filled the office of President, three vacancies.

Treasurer, one vacancy.

Ordinary Members of Council—

(*a*) Town Members (*i.e.*, those living within a radius of 50 miles from London), three vacancies.

(*b*) Country Members (*i.e.*, those living beyond a radius of 50 miles from London), three vacancies.

The Council has nominated Professor W. P. Wynne to the office of President. It has also nominated Professor J. F. Thorpe to the office of Treasurer.

(In October last, the Council appointed Prof. J. F. Thorpe as Treasurer until the next Annual General Meeting, to fill the vacancy caused by the retirement of Dr. M. O. Forster. It also appointed Dr. J. T. Hewitt as Vice-President until the Annual General Meeting to fill the vacancy amongst the Vice-Presidents caused by Prof. J. F. Thorpe's appointment as Treasurer.)

Fellows are reminded that nominations for any of the above vacancies may be made in writing, signed by at least twenty Fellows, and must be received by the Secretaries at the Society's Rooms not later than the 14th day of February, 1923. Every nomination must relate to one vacant place only, and must be accompanied by a signed declaration by the nominee that he is willing to accept office if elected.

Forms of nomination can be obtained on application to the Assistant Secretary.

The names of the Members of Council who retire at the Annual General Meeting on the 22nd March, 1923, and who are ineligible for re-election to the same office until after the lapse of one year, are as follows:—

President: Sir James Walker.

Vice-Presidents who have filled the office of President: Professor H. E. Armstrong and Professor W. H. Perkin.

Vice-Presidents who have not filled the office of President: Professor F. S. Kipping and Professor S. Smiles.

Ordinary Members of Council—

(*a*) Town Members: Professor A. J. Allmand, Mr. F. H. Carr, and Professor J. M. Thomson.

(*b*) Country Members: Professor T. S. Patterson, Mr. W. Rintoul, and Professor R. Robinson.

JAMES C. PHILIP,
IRVINE MASSON, *Secretaries.*

26th January, 1923.

SOCIETY OF GLASS TECHNOLOGY.

Prof. W. E. S. Turner, D.Sc., President, presided at the meeting of the Society of Glass Technology, held in Sheffield, on Wednesday, January 17.

A very cordial welcome to the meeting was given to Mr. H. L. Dixon, of Pittsburgh, U.S.A., who was at present visiting Europe. He was, said Prof. Turner, well-known not only in America, but also in England and on the Continent. He had

built nearly all the glass furnaces in America.

The first paper presented to the meeting was by Dr. W. H. Hatfield, and entitled "Stainless Steel, with some Consideration of its Application to the Glass Industry." At the outset, Dr. Hatfield stated that he did not know sufficient of the glass industry to do anything more than suggest some directions in which stainless steel might be useful. He remarked that the most important property of stainless steel was its resistance to corrosion and to oxidisation. The resistance to ordinary corrosion was not of much interest to glass technologists, but its resistance to oxidisation at high temperatures was of considerable interest, especially from the fact that at high temperatures it scaled much less than ordinary steels. Stainless steel had such different properties from ordinary steel that it must be studied as an entirely different material from many points of view.

After demonstrating how nitric acid rapidly attacked ordinary steel but left stainless steel unaffected, Dr. Hatfield said that stainless steel could now be made direct into castings, while sheet steel, which was very malleable, could also be made. The making of sheet steel was a development of the last two years. Then, again, it could be drawn into tubes, so fine that hypodermic needles were now largely made from stainless tubes. Turbine blades had been successfully turned, and in this case the steel was brought into contact with steam at high temperatures. He showed pieces of turbine blades that had been in use eighteen months and still retained their special properties. These, he compared to ordinary nickel steel, which lost so much material that they had ceased to function properly. Practically all the turbine manufacturers had adopted stainless steel as being the most effective material for the manufacture of blades.

Stainless steel, he went on, was an alloy of iron and chromium. It contained from 12 to 14 per cent. of chromium. The carbon content varied a little with the different types of stainless steel, but for general purposes might be considered to be about 0.30 per cent., which was very similar to ordinary structural steel.

Dr. Hatfield showed by lantern slides the action of various corrosive and oxidising influences on stainless steel. They were able to make a stainless steel which would be impervious to sodium sulphate, though some types of stainless steel were liable to be affected by continued contact with it. He showed micrographs illustrating the structure of various special steels, such as nichrome and tantiron. The former, he said, resisted oxidising influences and maintained its strength at high temperatures. Tantiron was not ductile, but relatively hard and brittle like cast iron.

With regard to the glass industry, he considered that stainless steels could be considered as alternatives for those now used, from two standpoints, which were the resistance to scaling and its strength at high temperatures. Stainless steel had a high tensile strength, equal to the best alloy steels, had a high fatigue range, and might be hardened and tempered. There were many directions in which the material might be useful, the most notable, in his opinion, being for parison and blow moulds. Many parts of feeder devices might be usefully produced in such material, as might also blowing irons, rolls, belt conveyers, lehr chain pins, and other things, including knives for cutting viscous glass. The ends of blowpipes might very well be made of stainless steel. Brushes which had to be made of wire could well be made of stainless steel.

Explaining recent developments in the use of this steel, Dr. Hatfield said that where a highly polished surface was needed, stainless steel was admirable for the purpose. Indeed, several firms were producing scientific mirrors from this material.

A discussion followed, in which there took part the President (Prof. W. E. S. Turner), Major V. F. Gloag, and Messrs. J. H. Davidson, W. C. Snowdon, R. Hemingway, and Guy Simpson.

Replying to the discussion, Dr. Hatfield said that the question of a good surface was answered by the manufacture of the mirrors be had referred to. He thought stainless steel would do very well in muffle lehrs. Stainless steel could be welded without any difficulty to stainless steel or ordinary steel, but a good deal depended on the skill of the smith employed. He thought that the moulds used in glassmaking were too heavy. Stainless steel could withstand the process of crushing and also ordinary wear and tear as well as most materials. He was not able to answer questions with regard to comparative costs, but the cost of stainless steel was something approaching the price of cheap high speed steel. It was a special steel, and not a cheap steel, but the cost

was not prohibitive. The expense was always justified when used in those industries where its special properties were an advantage over other materials.

The second paper was entitled "Some Measurements of the Viscosity of Glasses near their Annealing Points, and a critical Review of some recent literature on the Annealing of Glass," by S. English, M.Sc.

Mr. English showed that contrary to the general opinion, strain in glass could not always be detected by examining the glass in polarised light, and that the most sensitive position was that in which the direction of the strain in the glass was at 45° to the plane of polarisation of the light. In discussing strain viewers, the lecturer dealt with the defects in design of a strain viewer recently put on the market, and showed that with a strain viewer of this type it was very easy to obtain misleading indications of the presence of strain. Reviewing the statements made concerning the advantages accruing from the use of a selenite or quartz plate in connection with the analysing Nicol prism, it was shown that the claim made by one author that the selenite plate was more sensitive than plain crossed nicols was only true when a very poor source of light was used, and that a further claim made by another author to be able to distinguish between tension and compression stresses by the use of such a plate was entirely untrue.

Details of the measurements of the mobility of various types of glasses from the annealing temperatures through a range of 150° were given, and it was shown that the rate of change of mobility of the glasses at their annealing points was approximately constant, most of them requiring a rise of temperature of 9° to cause a doubling of the mobility. In some cases this temperature interval rose to as much as 11°. At temperatures of 100 or 150° above the annealing points the temperature interval required to double the mobility was generally rather longer than that required at the annealing points. Curves were shown indicating that the mobility of glasses is not a true logarithm's function of the temperature, and that a point of inflection in the curves will probably be found at temperatures rather higher than those included in the present range. It was also suggested that the well-known working properties of lead glasses and other soft glasses are determined more by the rate of radiation of heat than by rate of change of viscosity with temperature.

During the forenoon, by the courtesy of the directors, members had the privilege of visiting the works of Messrs. Thos. Firth & Sons, Ltd., Sheffield, where they saw various processes in the manufacture of stainless steel.

THE INSTITUTE OF CHEMISTRY OF *GREAT BRITAIN AND IRELAND.*

Pass List: January Examinations, 1923.

The following Associates have passed the examination for the Fellowship, in branch E, The Chemistry, including microscopy, of Food and Drugs:—

Two candidates were examined; both passed:

Hawley, John William, B.Sc. (Lond.).

King, John.

The following candidates have passed the examination for the Associateship:—

Current Regulations: in General Chemistry:

Fifteen candidates were examined; seven passed:

Bender, Gustave William, University College, London.

Cattle, Alfred Philip, East London College.

Lomax, James, College of Technology, Manchester.

Madden, Frank Cox, University College, London.

McKean, John Brown, Paisley Technical College.

Powell, Cyril John, University College, Nottingham.

Reynolds, Thomas Edward Stewart, University College, London.

Regulations prior to 1920; in branch (a), Mineral Chemistry:—

Two candidates were examined; both passed:

Dallimore, Thomas Warwick, Chelsea Polytechnic.

Smith, William, University College, Nottingham.

Regulations prior to 1920; in branch (d), Organic Chemistry:—

Three candidates were examined; all passed:

Hansford, Mitchell Harold, Blackburn Technical College.

Tadman, Vernon Thorpe, University College, Nottingham.

Taylor, George, University College, Nottingham.

By Order of the Council,
Richard B. Pilcher,
Registrar and Secretary.

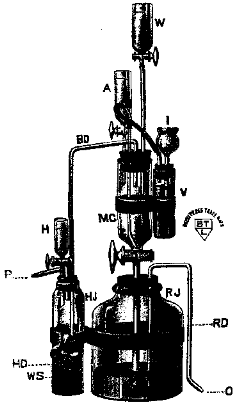
30, Russell Square, London, W.C.1.

APPARATUS FOR THE RECOVERY OF BROMINE FROM SODIUM HYPO-BROMITE.

By C. H. COLLINGS.

Erratum.

P. 57, third line of third paragraph of first column: after the words "with the evolution of free Br," insert "a constant stream of air-bubbles."



The above illustration shows the apparatus used.

A, acid cup; W, waste-cup; H, soda sol. cup; HJ, hypobromite jar supports on WS, with delivery tap HD; MC, mixing-chamber; V, valve; I, air inlet; BD, bromine delivery tube; P, connection with aspirator or pump; RJ receives residuum from the operation in MC, and is emptied when full through RD at O.

NOTICES OF BOOKS.

Common Science, by CARLETON W. WASHBURNE. Pp. XV. + 390. London: G. Bell & Sons, Ltd., Portugal Street, W.C. 1923. Price 4s. 6d.

A collection of answers to about 2,000 questions asked by children forms the foundation of this book.

These questions were selected from those asked by several hundred children in upper elementary grades. They were sorted and classified, and from them this course was constructed. The aim has been to select simple and striking experiments and illustrations which will stimulate and maintain the children's interest in the subject.

The assumption that the scientific method can be taught to children by making them carry out uninteresting quantitative experiments in an effort to obtain results that correspond with those in a text-book can be considerably over-rated.

In the present volume, exercises are selected to illustrate the scientific principles of Gravitation, Molecular Attraction and Capillarity, Conservation of Energy, Heat, Radiant Heat and Light, Sound, Magnetism, Electricity, and Chemical Change and Chemical Action.

The volume is intended for young pupils who are studying elementary science, and should be useful to their instructors as well. J.G.F.D.

Inorganic Chemistry, by G. S. NEWTH, F.I.C., F.C.S. New and enlarged edition. Pp. XIII. + 772. London: Longmans, Green & Co., Paternoster Row, E.C. 1923. Price 8s.

The continued popularity of Newth's "Inorganic Chemistry," as evidenced by the constant issue of new editions, is not difficult to understand.

The book is just the type which appeals to those tutors who take students to the Matriculation and Intermediate Science stages.

It also appeals to students who are largely left to their own initiative to acquire an elementary knowledge of chemistry. This may be due in some measure to the fact that the author's aim has been to include descriptions of as many experiments as is consistent with the correct presentation of the theoretical matter.

It may be urged that the time has come for such a volume to be entirely re-written, but this does not necessarily apply to such a subject as elementary inorganic chemistry, especially if the important new developments are indicated.

This text-book will doubtless continue to be used in many schools and other institutes by those students for whom it is intended. J.G.F.D.

We have received from Messrs. Adam Hilger, Ltd., 75a, Camden Road, London, N.W.1, a copy of the second edition of their

Optical Methods in Control and Research Laboratories, by J. N. GOLDSMITH,

PH.D., M.SC., F.I.C.; S. JUDD LEWIS, D.SC., F.I.C., PH.C.; and F. TWYMAN, F.INST.P. Vol. I., pp. 56 + IV. + plates.

This volume, which costs 1s. 6d., or 1s. 8d. post free, deals with Spectrum Analysis, Absorption Spectra, Refractometry, and Polarimetry.

In the preface it is rightly pointed out that there is a tendency to lose sight of the deeper significance of physical properties when they are merely used for identification or other technical purposes. This tendency should be guarded against, and this has certainly been the policy of Messrs. Hilger, who have, from time to time, published valuable information concerning their instruments and the physico-chemical applications for which these may be employed.

In the present pamphlet, Section I. deals with Spectroscopy and analysis by Emission Spectra. The use of spectrum analysis has been very considerably extended during the last decade. Recent applications are very numerous, as is indicated by the references quoted. Section II. gives an account of Absorption Spectra and Spectro-photometry. Section III. is devoted to the Refractometer and its uses; and finally Section IV. deals with the Polarimeter. These sections are all followed by lists of references to the important and cognate publications on these subjects.

The pamphlet is thus seen to be of considerable value to the users of these physical instruments.

The Association of British Chemical Manufacturers, 166, Piccadilly, W.1, have sent us an *Official Directory of Members with a Classified list of their Manufactures.*

This directory should assist buyers of chemical products at home, in the colonies, and abroad. There are keys to the index in French, Spanish, Italian, Portuguese and German, which considerably enhance the utility of this directory, copies of which may be purchased at the offices of the Association, price 10s. 6d.

BOOKS RECEIVED.

Seifen Und Eiweissstoffe, von MARTIN H. FISCHER unter Mitarbeit von George D. McLauglin und Marian O. Hooker. Autorisierte Deutsche Ausgabe von DR. JOHANN MUTALA. Pp. 188. 1922. Dresden and Leipzig: Verlag von Theodor Steinkopff. 4s. 3d.

A Text-Book of Inorganic Chemistry, by G. S. NEWTH, F.I.C., F.C.S. Pp. XIII. + 772. New and enlarged edition, 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 8s.

Outlines of Theoretical Chemistry, by FREDERICK H. GETMAN, PH.D. Pp. VIII. + 625. Third Edition, 1922. Messrs. Chapman & Hall, 11, Henrietta Street, Covent Garden, W.C.2. 18s. 6d. net.

Questions and Problems in Chemistry, by FLOYD L. DARROW. Pp. VII. + 177. 1923. Messrs. G. Bell & Sons, Ltd., York House, Portugal Street, W.C.2. 3s. 6d. net.

New Patents.

THIS list is specially compiled for the *Chemical News,* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Abstract Published this Week.

Lead Sulphate.—Patent No. 189160.—The invention is related to a process described in Specification 5299/15, granted to Messrs. J. Gitsham and H. R. Evershed, of 175, George St., Launceston, Tasmania, wherein sulphate, sulphite, and oxide of lead are obtained directly from the native sulphide by volatilising the latter in an electric furnace. The present invention aims at the production of a product free from sulphide, oxide, or unchanged sulphide. The finely crushed ore, which may have been previously concentrated, falls in regulated quantities from a feeding apparatus through the guide tubes on to the electrodes of the furnace. These are arranged in pairs, and are placed about nine inches above the floor of the furnace. About five feet above the arcs is an atmospheric intake communicating through a bifurcated flue with a fan chamber. A fan induces a current of air over the furnace shaft, and the fan chambers deliver into spray boxes, wherein the fumes are subjected to the action of water sprays delivered from a perforated pipe. A chimney assists the flow of air and fumes through the apparatus. The water containing the reaction products passes through launders into vats, where it may be warmed and agitated by steam pipes placed on the floor of each vat. The finely crushed sulphide falls on to the arcs, and is at once volatilised. The vapours rise up the furnace shaft into the current of air passing through the top of the furnace, and are then oxidised. The reaction products, having been delivered into the vats, they are agitated, and free acid may be added if necessary, to convert any sulphites or oxides present into sulphates. The agitation serves to float any sulphide that may have escaped volatilisation. This is skimmed off, dried, and retreated. The remaining liquor is neutralised with lime, and the sulphates finally allowed to settle, decanted, and dried for use as a pigment.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post-free for the official price of 1s. each.

THE CHEMICAL NEWS.

VOL. CXXVI. No. 3279.

PASTEUR.

On Friday, February 2, a lecture was delivered, in French, under the auspices of the Alliance Française, by Doctor Pasteur Vallery-Radot, Médecin des Hôpitaux de Paris, in the rooms of the Royal Society, Burlington House. The Chairman was Sir Charles Sherrington, President of the Royal Society.

The lecturer was the grandson of the great scientist, and had lived with him in his youth; he stated that among all the homages paid to him on the occasion of the hundredth anniversary of his birth, none would be dearer to Pasteur than that England is paying him this month, because it is the land of Jenner and Lister, and because here he found his warmest partisans and some of his greatest friends.

Before Pasteur, medicine knew nothing of the cause of virulent illnesses; surgeons dared no longer operate, infection was the fear of maternity hospitals, the industries based on fermentation were powerless, herds were dying fast. In 40 years, Pasteur's genius changed all.

At 22 he already ranked as a great scientist, and from his study of crystals he was led to study fermentation, and whence he touched on the question of the "spontaneous generation of life."

He was a man who liked to obtain results, and he showed at once how the various industries could benefit by his studies on fermentation; he thus gave practical help to the wine, beer, dairy, vinegar, and bread industries; in a word, all that touches the necessities of life benefited through his work.

In 1865 he began the study of the plague which was ruining the silk industry, and succeeded in discovering the microbe which killed the silkworms. He then turned to help medicine and surgery. In 1877 he studied that disease, anthrax, which was killing cattle in such a quantity at this time; then fowl pestilence, or chicken cholera. He was dominated by the idea of saving humanity from epidemic, and was led to the discovery of vaccination by experiments carefully done. Microbes were thus transformed from an instrument of death into an instrument of preservation.

Pasteur studied rabies, and had there to fight hard against opposers who called him a murderer on account of his experiments on animals.

The work of Pasteur is, by its logical linking and its incalculable consequences, one of the most wonderful productions of man's genius; he had an extraordinary imagination, but he tempered it by the most strict experimentation. This is particularly exemplified by his researches upon disymmetry.

But if Pasteur was great by the mind, he was as great by the heart. Modesty was his great characteristic. To his father and mother he gave thanks for what life had given him. His work and his home life were closely linked because Madame Pasteur was his help in every moment.

He closely bound together the love of his country to his love for humanity. He often said that if Science had no country, the scientist should have one. His ideal was to see humanity lead to peace by the aid of science.

His grandson, a medical man by profession, is also a distinguished biologist; he has given special attention to the study of hypersensitiveness in *asthmas urticaire*, and its gradual or sudden cure by the swallowing before meals of a certain dose of peptone in tablets. He is also very deeply interested by the study of kidney troubles.

Mr. A. Chaston Chapman, President of the Institute of Chemistry, proposed the vote of thanks, and expressed the opinion that the thanks of the audience were due to the lecturer for his clear exposition of the achievements of his grandfather. As a chemist, he was specially interested in Pasteur's chemical achievements, by which he commenced his illustrious career.

The vote was seconded by Prof. Martin, and was carried with acclamation.

THE RARE EARTHS AND THEIR METALS.

II.—Modified Methods of Separation.

By John Missenden, B.Sc.

(*Continued from Page 55.*)

(*a*) Apart from periodic classification, which may only be considered for the evolution of new lines of research, the rare earth metals may, for all practical purposes, be divided into two groups:

(*a*) The cerium group: Ce, La, Pr. Nd, (Di), Dp, Gd, Sm, etc.;
(*b*) The yttrium group: Y, Yb, Sc, Lu, Ho, Er, Tr, Tm, etc.

The division of the metals depends upon the solubility in a saturated solution of potassium sulphate of the double potassium salt having the general formula, $R_2(SO_4)_3.3K_2SO_4$, group (*a*) being precipitated.

(*b*) The main method of effecting a separation—specifically, in the case of splitting up a complex earth—is by the fractional precipitation with ammonia. The process, while standardised more or less, *admits of some variation, and discrimination has been difficult. In simple analysis* (*i.e.*, where an unknown earth has to be examined) the elimination of a certain amount of tedium seems barely possible. Where, however, a known earth is applied to the extraction of a specified oxide, by a *careful examination of these variations*, a really convenient process has been found, and may serve for general adoption in the laboratory. It is not put forward as a suitable process for separations on a considerable scale, however, for two reasons: firstly, ammonium salts are split up by *praseodymia: and, secondly, the hydroxides* are difficult to isolate.

(*c*) The fractionation referred to is based on Drossbach's explanation (*Ber. Deut. Chem. Ges.*, 1902, XXXV., 2826). He boiled the specimen earth in an ammonium salt, rendering soluble the more basic *metals by displacing the ammonia.* Precipitation, stage by stage, then takes place from the complex solution.

Where the earth contains large quantities of ntrates in natural form—this is the rule rather than the exception—it is as well to precipitate slowly by the usual method of *ammonium-fractionisation.* When the bulk of the natural nitrates have been dealt with, resort should be made to the ammonium-salt method of Drossbach. The most basic metals, *i.e.*, lanthanum, neodymium, praseodymium, gadolinium, and samarium, are left in the filtrate after the first process.

The continuation of the separation is engineered by repeating the fractionisation, this tie dissolving the hydrides in *dilute* hydrochloric acid (not concentrated, as has been described in another work) of 0.125 strength, an excess of analine being added. Ammonia *is then admitted to the solution* drop by drop, and a quite accurate fractionisation of those earths which are least soluble in analine hydrochloride results.

(*d*) The double ammonium nitrates of the $R(NO_3)_3.2NH_4NO_3.4H_2O$ order were submitted to a crystallisation process by Welsbach, who produced the two components of didymium by this process. The most soluble fractions were found to be the metals of the yttrium group. Drossbach (*Ber. Deut. Chem. Ges.*, 1902, XXXVIII., 2825) discovered a method whereby praseodymium and neodymium could be more speedily obtained, and it is a variation of the above. The difficulty of effecting a separation between lanthanum and didymium was overcome by Denis and Lemon (*Journ. Amer. Chem. Soc.*, 1915, XXXVII., 131), *who resorted to fractional electrolysis.* The separation of other earths will be found in a table of general reference at the end of this section.

(*e*) Bunsen devised the original method of separation by nitrate ignition. The principle *of this process is briefly the fusion* of a series of nitrates in complicated mixture, scandium having the lowest melting point of the yttrium group, and yttrium the highest. More energetic applications of heat cause decomposition of the nitrates in chemical mixture over the same range. *Undecomposed matter is removed in each* case by dissolving in water, and the precipitate freed by filtering.

(*f*) With regard to the content of the rare earths, Sir William Crookes, following a line of study parallel to that of Nilson and Krüss, arrived at a remarkable conclusion. Nilson and Krüss carefully examined the absorption spectra of the metallic nitrates obtained from a wide range of earthy specimens, and observed that the intensity of the absorption bands for different specimens was not identical. Crookes, examining the phosphorescent spectra, upheld this quite feasible opinion. The different phosphorescent spectra of the two separate basic fractions of yttria is a case in point, the two analyses each having their own characteristics.

(*g*) A complete separation, applicable to many of the rare earths, is described as under. It is a modification of S. J. Johnstone's method for the constitutional determination of monazite (*Journ. Soc. Chem. Ind.*, 1914, XXXIII., 55), incorporating investigations by Mosander, whose work in obtaining ceria is mentioned in I. (*d*) of this treatise.

The earth to be examined is completely dissolved in concentrated sulphuric acid, the ratio of the acid to the earth being as 3:1, and poured into 200 cc. (or even more)

of *distilled* water. The precipitate is taken away, and the process upon it repeated two or three times, the final washing taking place for several hours. The remaining liquid is poured into 500 cc. of weak ammonia solution, and, after half an hour, 250 cc. of hydrochloric acid solution (strength 0.1) is added slowly. 12 g. of ammonium oxalate (compare the works of Glaser) will commence precipitation. Here is the main deviation from Johnstone's *method*. When *precipitation has stopped*, the residue should be taken from the solution, reprecipitated and thoroughly cleansed in distilled water. 2 more g. of the oxalate added, and the next precipitated in a like manner; and so on, in 2 g. *operations*, until precipitation ceases. There will probably be six or seven grades of insolubles. (In the examination of pyrochlor by this method, nine separate precipitates were made. The first three were mixed together for the extraction of thorium, and the remainder put aside for further investigation. Originally, 10 grams of pyrochlor were used, and gave the results found on p. 54 of the *Chem. News*, Vol. CXXVI., very nearly.*)

A part of these insolubles can be redissolved in hydrochloric acid (say 1 g. of insoluble to 35 cc. of a 0.1 solution after contentration treatment), and the whole made up to 250 cc. by the addition of water and sufficient ammonia to neutralise. 8 g. of sodium thiosulphate is then added to the former liquid at *boiling-point*, the whole being immediately cooled to 10° C. below the point of ebullition, and allowed to simmer for three days or more (the longer time causing the whole of the thorium to combine with the sulphate, thus eliminating further treatment with nitric acid afterwards).

The filtrate is now heated, and the water distilled off. The residue is dissolved in 20 cc. of hydrochloric acid, made up again to 250 cc., and oxalic precipitation again takes place to free the sulphate. This precipitate is treated precisely as explained by Johnstone from here to the end of the yttrium-earth extractions.

* *Pyrochlor was examined after the compilation of the table mentioned, and a note as to its composition will be added at the end of this section. A brief description of lanthano-tantalite will appear shortly.* [Ref.: I. (*h*).]

In the division of the cerium-earths (*i.e.*, ceria, lanthana, and didymia, *etc.*), the processes of Mosander are closely followed. Greater care is, however, exercised, in precipitation and purification. Lanthana and didymia are also precipitated as oxalates, and *treated with nitric acid*. *The melting* point of mixed lanthanum and didymium nitrate is about 428° C. when the mixture is in equal proportions. The molten liquid resolidifies in crystalline form, which, on *boiling with* 10 parts of water, throws down the basic salt. The soluble portion is fractionally separated, as has been previously described.

(*h*) The metal celtium has an oxide whose basic strength is between scandia and butecia, which is not as basic as neoytterbia (Blumenfeld and Urbain, *Compt. Rend.*, 1914, CLIX., 323).

(*i*) *References*:—

Celtium: Urbain: (*Comptes Rend.*, 1911, CLII., 1bl).

Cerium: Schützenberger (*Compt. Rend.*, 1895, CXX., 663).

Brauner (*Chem. News*, 1895, LXXI., 283).

Nordenskiöld (*Pogg. Ann.*, 1861, CXIV., 612).

Decipium: Delafontaine (*Compt. Rend.*, 1878, LXXXVIII., 578).

Dysprosium: Cleve (*Journ. Chem. Soc.*, 1895, i., 476).

Erbinm: Lecoq de Boisbaudran (see *Dana*).

Lecoq de Boisbaudran (*Compt. Rend.*, LXXXVIII., 323).

Gadolinium: Marignac (*Ann. Chim. Phys.*, 1880 [V.], XX., 535).

Holmium: S. I. Levy (*The Rare Earths*).

Lanthanum: Muthmann and Rölig (*Ber. Deut. Chem. Ges.*, 1898, XXXI., 1718).

Drossbach (*ibid.*, 1902, XXXV., 2826).

Lutecium: Urbain (*Compt, Rend.*, 1907, CXLV., 759).

Welsbach (*Monatsh. Chem.*, 1913, XXXIV., 1713).

Neodymium: Baskerville and Stevenson (*Journ. Amer. Chem. Soc.*, 1904, XXVI., 54).

Praseodymium: Schéele (*Ber. Deut. Chem. Ges.*, 1899, XXXII., 409).

Meyer (*Zeitsch. anorg. Chem.*, 1904, XLI., 94).

Scandium: Nilson (*Ber. Deut. Chem. Ges.*, 1879, XII., 554).

(*ibid.*, 1880, XIII., 1439).

Samarium: Boisbaudran (*Compt. Rend.*, LXXXVIII., 323).
Terbium: Krüss (*Zeitsch. anorg. Chem.*, 1893, IV., 26).
Thulium: Welsbach (*Monatsh. Chem.*, 1913, XXXIV., 1713).
Ytterbium: Marignac (*Compt. Rend.*, 1878, LXXXVII., 578).
Yttrium: Cleve (*Compt. Rend.*, 1882, XCV., 1125).

(*j*) *Note on the Composition of Pyrochlor.* The specimen was obtained from Impilako in Finland, and bore much resemblance to that examined by Rammelsberg. Unfortunately, the total of the constituents only reached 98.72. The specimen contained 55 per cent. of niobium pentoxide, 10.52 per cent. of titanium dioxide, 8.1 per cent. of thorium dioxide, 6.37 per cent. of cerium sesquioxide. The amount of thorium dioxide noted on the table (p. 54) for this earth is 10.98 per cent., not 10.47.

(*To be continued.*)

THE ACTION OF POTASSIUM CYANIDE ON MONOCHLORAMINE.

By W. F. Short, M.Sc., A.I.C.

The cyanamide required for an investigation of the interaction of its hydrochloride with phenolic substances (Short and Smith, T., 1922, CXXI., 1803) was not available from the usual sources. The interaction between potassium cyanide and monochloramine was examined in the hope that cyanamide would be produced according to the equation:

$$KCN + NH_2Cl = KCl + NH_2{:}CN.$$

Raschig (Verh. Ges. deut. Naturforsch. Aetze, 1907, II., 120) states that monochloramine reacts with potassium cyanide in aqueous solution to produce cyanogen chloride and ammonia, but since Cloëz and Cannipzaro (Ann. 1851, LXXVIII., 229) have shown that these substances react to produce cyanamide, it was anticipated that by employing suitable experimental conditions cyanamide would be the main product. Instead of the anticipated result, the interaction led to the formation of dicyanimide, a new substance recently described by Franklin (J. Amer. Chem. Soc., 1922, XLIV., 497), who prepared it by fusing sodamide with melon or by igniting sodium cyanide with mercuric cyanide.

The interaction of potassium cyanide and monochloramine takes place according to the following equation:

$$2KCN + 2NH_2Cl = 2KCl + NH_3 + NH(CN)_2.$$

It seems probable that the dicyanimide is produced by the interaction of cyanogen chloride with cyanamide, these substances being first produced according to the equations:

$$HCN + NH_2Cl = NH_3 + CN\cdot Cl.$$
$$KCN + NH_2Cl = KCl + NH_2\cdot CN.$$

Experimental.

A solution of sodium hypochlorite containing approximately one gram molecule per litre was prepared by passing chlorine into an ice-cold solution of slightly more than two gram. molecules of caustic soda in a litre. To this solution, one equivalent of ammonia in semi-normal solution was slowly added by means of a capillary tube. One equivalent of potassium cyanide in concentrated solution was then added in a similar manner. The admixture of these reagents was carried out in a flask immersed in a freezing-mixture, the temperature being maintained below 5° C. After standing for five hours in an ice-chest, ammonia was added in sufficient quantity to retain in solution the silver cyanide produced on the subsequent addition of silver nitrate. A precipitate of glistening white crystals quite distinct from silver cyanide in appearance was produced. These crystals were collected, washed with a little water, and thoroughly dried in air. They darkened superficially on exposure to sunlight. Strong ignition produced a mixture of silver and silver chloride.

0.2015 gram left a residue of 0.1595 grams on ignition. ($AgN(CN)_2{:}AgCl \rightarrow Ag + AgCl$ requires 0.2015 gram $\rightarrow$ 0.1596 gram). The residue, after treatment with nitric and hydrochloric acids weighed 0.1816 gram, whence Ag = 67.82 per cent. ($AgN(CN)_2\cdot AgCl$ requires Ag = 68.01 per cent.). A determination of the nitrogen content by Kjeldahl's method gave N = 13.0 per cent. ($AgN(CN)_2\cdot AgCl$ requires N = 13.25 per cent.).

Hydrogen chloride in ether decomposed this double compound, thus:

$$2HCl + AgN(CN)_2{:}AgCl = 2AgCl + (CN)_2\,NH\cdot HCl.$$

It was found that dicyanimide hydrochloride could be titrated with potassium hydroxide using phenolphthalein as indicator:

$$(CN)_2\,NH\cdot HCl + 2KOH = (CN)_2NK + KCl + H_2O.$$

Biuret was produced by warming the hydrochloride with water. Cold hydrochloric acid converted the silver compound into cyanocarbamide, $NH_2 \cdot CO \cdot NH \cdot CN$, characterised by its copper salt. By treating the silver compound in aqueous suspension with hydrogen sulphide, removing the silver sulphide and concentrating the solution in vacuo, a jelly-like mass separated out. This appeared to consist for the greater part of an insoluble amorphous polymer of dicyanimide. On neutralising a dilute aqueous solution of dicyanimide with caustic soda and adding silver nitrate, a bulky white precipitate of the true silver derivative, $AgN(CN)_2$, is obtained.

I have to thank Mr. R. Gardner, B.Sc., for assistance in carrying out the preliminary experimental work.

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PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, FEBRUARY 1, 1923, AT 4.30 P.M.

The following papers were read:—

PROF. O. W. RICHARDSON, F.R.S. *The Magnitude of the Gyromagnetic Ratio.*

This note discusses various possibilities as to why this ratio has the value m/e instead of 2 m/e, the value calculated on the turning electron orbit theory of magnetism of the Langevin type, and suggests that the discrepancy is due to the rotation of the atomic nucleus. In the case of iron it appears that the effective electron orbits possess altogether two quanta of angular momentum per atom and the nucleus a single quantum of angular momentum on this view.

SIR RICHARD PAGET, BART. *The Product of Artificial Vowel Sounds.* Communicated by Sir William Bragg, F.R.S.

Experiments were made with plasticene resonators to imitate resonances heard by the writer in his own voice when breathing various English sounds. The first models were made in rough imitation of the oral cavity, and were found to give two double resonances.

Experiments were made with these models to ascertain the effects of alterations of form on the natural resonances of the model when tapped or blown through. The models were then tuned by appropriate alterations of form to give resonances similar to those heard in **ɛ** (earth) and a (calm) in the writer's voice. They then gave recognisable breathed vowel sounds when blown through a small orifice at the back.

An artificial larynx was made by means of a rubber strip laid edge-wise across a flattened tube, and, when blown through this larynx, the models gave recognisable voiced vowels.

Further experiments indicated that the oral cavity behaves in every case as two Helmholtz resonators in series, and the remaining vowel sounds were reproduced by forming two separate resonators joined together in series, and made of such capacity and size of orifices as to allow for mutual reaction of resonators on their respective resonant pitch.

In one case the vowel sound **u** (who) was apparently produced by a single resonator when blown by mouth through an artificial larynx. It was found that the vowel sound was due to the fact that the mouth cavity acted as a second resonator, *i.e.*, that vowels may be produced by two resonators in series with a larynx between them. Certain vowel sounds in the mouth can be changed into others by adding a resonant capacity on to the mouth.

With a single cylindrical resonator, and with an ovoid resonator, it was found that when blown through by means of a small orifice at the back two or more resonances were given, some bore correct pitch relation to one another to give certain vowel sounds, *i.e.*, a single tubular resonator may act as two resonators in series.

Two resonators in parallel, blown by means of a single larynx with a bifurcated passage, produced vowel sounds indistinguishable from resonators in series.

F. SIMEON. *The Carbon Arc Spectrum in the Extreme Ultra-Violet.* Communicated by Prof. A. W. Porter, F.R.S.

The results of this investigation may be stated as follows:—

(1) The arc-spectrum of carbon has been shown to give lines in the Lyman region at 1194, 945, 858, 687, 651, 640, 599 and 595, which have not been previously observed, and which correspond with prominent lines in the "spark" spectrum studied by

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(2) Groups of lines have been found at 1657, 1560, 1335, 1329, 1260, 1194, 1175, 1036 and 651, of which those at 1329, 1260, 1194, 1036 and 651 do not seem to have been observed by any other worker, and that at 1657 has not been completely resolved heretofore.

(3) A new determination o fwave-length has been made of the prominent lines in the carbon arc-spectrum.

PAPERS READ IN TITLE ONLY.

PROF. J. JOLY, F.R.S. *Pleochroic Haloes of Various Geological Ages.*

PROF. H. A. WILSON, F.R.S. *The Motion of Electrons in Gases.*

H. HARTRIDGE. *The Coincidence Method for the Wave-length Measurement of Absorption Bands.* Communicated by Prof. J. N. Langley, F.R.S.

(1) Measurements of the absorption bands of pigments by means of the ordinary spectroscope are found to be inaccurate because of the breadth of the bands and the indefiniteness of their margins.

(2) The adjustment of two similar absorption bands into coincidence is found to be effected with considerable accuracy. If then a spectroscope is designed in which two spectra are seen side by side on looking down the eyepiece, but reversed in direction with one another, the measurement of the mean wave-length of the absorption bands can be accurately carried out.

(3) The optical construction of the instrument is described in Section 3.

(4) The method of calibrating the micrometers of the spectroscope are described, and experimental values are given to show the accuracy obtained.

(5) The method for the quantitative estimation of pigments by the wave-length measurement of their absorption bands is described. The estimation is shown to depend on the movement of the bands which occurs when the concentration of one pigment changes.

(6) An example of the method is given, namely, the estimation of the percentage saturation of blood with CO gas by the measurement of the wave-length of the α-absorption band. The accuracy of measurement is found to be approximately 0.7 A.U.

(7) Sources of error in the method are considered, and probable accuracy of measurement discussed. The probable error in setting two absorption bands into coincidence is found but little greater than that of setting two sharp black lines into coincidence, or of making one line bisect the area between two others.

A. BERRY and LORNA M. SWAIN. *On the Steady Motion of a Cylinder through Infinite Viscous Fluid.* Communicated by H. W. Richmond, F.R.S.

This paper offers another partial solution of the problem of the motion produced by a cylinder, moving with uniform velocity through infinite viscous fluid. The so-called "inertia" terms are neglected and a solution is found which satisfies the boundary conditions on the cylinder and makes the velocity only logarithmically infinite in one direction at infinity. The relative velocity increases comparatively slowly with the distance from the cylinder and the solution may be expected to give a fairly good approximation to the motion at small distances from the cylinder.

In the first place the problem is solved by treating the elliptic cylinder as a limiting case of the ellipsoid. The solution, which in the case of the ellipsoid satisfies the boundary conditions and those at infinity, leads to a solution for the elliptic cylinder, which has the velocity at infinity logarithmically infinite in one direction. The plane laminæ, both along and perpendicular to the stream, are considered as limiting cases, and further, the motion due to the circular cylinder is deduced as a special case of the elliptic cylinder.

Secondly, the solutions for the elliptic and circular cylinders are obtained directly from the equations of motion.

Finally, stream-lines, curves showing variation of velocity along stream-lines and curves of constant velocity are drawn for three limiting cases.

Some numerical results are given to show how slowly velocity does increase with distance from the cylinder. From these we are able to conclude that it is probable that the theory represents the facts fairly accurately for some considerable distance from the cylinder.

W. JEVON. *The Line Spectrum of Chlorine in the Ultra-Violet (Region λ3354-2070 A).* Communicated by Prof. H. C. Plummer, F.R.S.

(1) Observations of the spectrum of the Cl discharge tube, which have not hitherto extended lower than λ 3276 A (Eder and Valenta) have been continued as far as λ 2070 A, by means of 10-feet grating and quartz-prism spectrographs.

(2) Wave-lengths and wave-numbers of nearly 200 newly observed Cl lines are re-

corded, together with the effects of variations of capacity on the intensities of more than 100.

(3) The constant differences ($\Delta\nu$) 40.4, 67.1, 107.5, found by Paulson in pairs and triplets above λ 3276 A recur in a few pairs below that point. The significance of these separations in relation to the analysis of the spectrum, however, appears doubtful, since—

(a) There is no apparent regularity in the intensities of the lines involved; and

(b) No triplets having these separations been detected in the region under investigation.

M. H. Evans and H. J. George. *Note on the Adsorption of Bases by Solids and the Thickness of the Adsorbed Layer.* Communicated by D. L. Chapman, F.R.S.

The authors have determined the amount of carbon dioxide adsorbed by unit surface of glass, at a pressure approximating to one-sixth of an atmosphere, and their results are in agreement with the assumption that the carbon dioxide is condensed on the surface of the glass in a liquid layer having a thickness equal to between five and six times the diameter of the molecule of the gas.

By combining this result with the published figures of Mülfarth (*Ann. d. Physik*, 1900, Vol. III., p. 328) on the relative adsorption by glass of the gases—acetylene, nitrous oxide, carbon dioxide, sulphur dioxide and ammonia—they deduce that at the same pressure these gases are adsorbed by the surface to such an extent that if they were present as liquid layers, the thickness of the layers would vary from (in the case of acetylene) three, to (in the case of ammonia) forty molecular diameters.

A direct determination of the degree of adsorption of NH_3 made by them furnished a value which was of the same order as that calculated, as above, from Mülfarth's data.

The results are in disagreement with Langmuir's recent generalisation that the forces of attraction exerted by a surface do not extend to a distance greater than the diameter of one molecule.

Prof. L. Bairstow, F.R.S., Miss B. M. Cave, and Miss E. D. Lang. *The Resistance of a Cylinder moving in a Viscous Fluid.*

The equations of motion of a viscous fluid in the approximate form proposed by Oseen have been taken as a basis for new calculations on the resistance of cylinders. Calculations are given in the paper for the resistance of a circular cylinder, and for the surface friction along a plane. In the case of the circular cylinder experimental information obtained at the N.P.L. is wholly suitable for the purposes of comparison with the present calculations. A resistance co-efficient is found which is about 30 per cent. greater than that observed at the limit of the range of observation.

The calculations represent an extension of the solution by Lamb from values of Reynolds' number, *i.e.*, Ud/ν, which are small (0.2 approx.) to values which may be as great as desired; the comparison with experiment is first made with $Ud/\nu = 12$. The only approximation, other than percentage accuracy of computation, is that represented by Oseen's form of the equations of motion; it is proposed to attempt the calculation with the full equations proposed by Stokes in order to account for the remaining 30 per cent. difference.

Calculations for the plane show singularities at the edges, but lead to a resistance which is in rough agreement with experiment. Exact comparison is not possible because the experiments were not carried out under conditions which sufficiently approach two-dimensional flow.

The analysis has been extended to cover the calculation of the resistance of a cylinder of any form for the same approximate differential equation. Whereas the circular cylinder and plane have been treated by analytical methods, it appears tnat graphical methods are required for the more general boundary form.

G. I. Taylor, F.R.S. *The Motion of Ellipsoidal Particles in a Viscous Fluid.*

The experiments here described were undertaken in order to test experimentally an unproved hypothesis recently introduced by Dr. G. B. Jeffery. The hypothesis was that ellipsoidal particles immersed in a moving viscous fluid would assume certain definite orientations in relation to the motion of the fluid. It wes found that ellipsoidal particles made of aluminiuc and immersed in water glass do in fact take up the positions indicated by Dr. Jeffery, but they take a long time to get to those positions. During the time in which the particles are gradually approaching their final positions they oscillate in the way indicated in Dr. Jeffery's analysis.

Prof. W. E. Dalby, F.R.S. *Further Researches on the Strength of Materials.*

This paper describes my recent researches on the strength of materials, and is in continuation of papers published in *Proc. Roy.*

Soc., A, vol. 86, and vol. 88, and in *Phil. Trans.*, A. vol. 221.

The papers describe first, a new apparatus by means of which an alternating load, push and pull, can be applied to a test piece in such a way that the curves of load and elastic extension are recorded photographically. Two records are shown, the one in which a test piece was broken down in tension, and the other in which a similar test piece was broken down in compression. The immediate deduction from the records is that the yield in tension and compression is substantially the same, and that the modulus of elasticity is the same. But the point of greater interest is that alternating load is met by alternating response. When a load of either sign is removed the response is elastic, but imperfectly so. When a load is re-applied, but of opposite sign to the load removed, the response is mainly plastic. This alternating response to alternating loading is discussed in the light of the experiments of Ewing and Rosenhain and the recent researches of Carpenter.

The fact that Carpenter has found the elastic properties of an ordinary test piece reproduced in a test piece turned from a single crystal, definitely eliminates the amorphous network and allows the discussion to be based on the fact that elastic property resides mainly in the crystalline structure.

Many points requiring investigation are noted. A new instrument is then described by means of which an alternating torque and elastic twist are recorded photographically. A record is shown from which it is seen that alternating torque is also met by an alternating response in shear. Reference is then made to the possibility of predicting a practical fatigue limit from these diagrams.

Lewis F. Richardson. *Theory of the Measurement of Wind by Shooting Spheres Upward.* Communicated by Dr. G. C. Simpson, F.R.S.

During the last fifteen years a vast amount of information concerning upper wind has been obtained on occasions when the air was clear enough to allow a small rubber balloon to be seen through a theodolite. Some observations of wind above fog or low cloud have been made by tethered balloons carrying instruments, or by the method of sound ranging; but these observations are very scanty.

The new method, the theory of which is here described, is independent of visibility. A steel sphere, about the size of a pea or a cherry, is shot upwards from a gun, which is not rifled. The gun is inclined from the vertical towards the advancing air, and the tilt adjusted by trial until the returning sphere falls very close to the gun. The tilt is then some measure of a weighted average of the wind, in the region extending from the ground up to the maximum height attained. This height is found from the time of absence of the sphere, which is recorded by a stop-watch.

The observation of the tilt and time is repeated for greater and greater heights in succession. The result may be said to depend upon a set of weighted averages of wind up to successive heights; and the problem is to undo the averaging process, and so find the wind at each level. A condition of the problem is that the computation of the winds should not occupy the observer for more than about fifteen minutes.

Mathematically speaking, the problem involves a " linear integral equation of the first kind." This is solved approximately by transforming it into a moderate number of algebraic simultaneous equations. The error due to the finiteness of the number of these equations is studied by varying the number.

In the general part of the theory it is necessary to make an approximation which fails at the vertex of the trajectory. So for the sake of observations in which the important part of the path is near the vertex, there is given either a special and sufficiently correct theory or else a correction to the general theory.

Ernest Wilson. *On the Susceptibility of Feebly Magnetic Bodies as affected by Tension.* Communicated by Prof. O. W. Richardson, F.R.S.

The experiments demonstrate that when magnetite is subjected to tensile stress ranging from about 50 to 130 kgm. per sq. cm. as a maximum, the susceptibility for a given value of the magnetic force at first increases and then decreases as the specific load continuously increases, and exhibits a reversal point as in iron. The magnetic force at which the percentage increase in permeability has a maximum value is less than the magnetic force at which maximum susceptibility occurs. The specimens

tested have widely different structural characteristics.

PAPERS READ IN TITLE ONLY.

L. C. JACKSON and PROF. H. KAMERLINGH ONNES, FOR. MEM. R.S. *Investigations on the Paramagnetic Sulphates at Low Temperatures.*

L. C. JACKSON and PROF. H. KAMERLINGH ONNES, FOR. MEM. R.S. *Investigations on the Paramagnetism of Crystals at Low Temperatures.*

W. D. WOMERSLEY. *The Specific Heats of Air, Steam, and Carbon Dioxide.* Communicated by Sir Dugald Clerk, F.R.S.

D. W. DYE. *The Valve-maintained Tuning Fork as a Precision Time Standard.* Communicated by Sir Joseph Petavel, F.R.S.

An investigation has been made of the variations in frequency of a valve-maintained tuning fork, when alterations were made in various quantities which might be expected to cause variations in frequency. The following quantities were varied:—

(*a*) Temperature.
(*b*) Anode voltage and filament brightness.
(*c*) Capacity connected in parallel with grid and anode windings respectively.
(*d*) Polarising magnetic field strength.
(*e*) and (*f*)Energy taken from the system and the method of doing this.
(*g*) Effective mass of different parts of the mounting and orientation of the fork and mounting in space.

In addition, various valves were tried and absolute measurements made of the frequency in terms of a standard clock, to a high order of accuracy.

The conclusions arrived at were as follows: The valve-maintained fork is steady in frequency to a degree beyond that required for most purposes. The most serious cause of variation of frequency is that due to temperature. The temperature must be kept constant to 0°.1 C. if accuracy to one part in a hundred thousand is required. By the use of a special steel known as "elinvar," having very small temperature coefficient of elasticity, it is probable that the variation of frequency with temperature could be reduced to one-tenth that of ordinary steel forks.

The other factors causing variation of frequency are not themselves variable without attention to an extent which would cause a variation of more than a very few parts in a hundred thousand. By suitably choosing the capacities and the anode voltage of batteries of + 10 per cent. will cause a change of only about one part in a million in frequency.

By observation of care in the adjustments of the factors affecting frequency, it is probable that sufficient accuracy would be attainable to observe diurnal variations in the rates of standard clocks, and perhaps in the value of "g."

[*The abstracts are provided by the authors of papers, and are not to be communicated to any journal for publication until after the meeting.*]

At the meeting on February 22, the Bakerian lecture will be delivered by G. I. Taylor, F.R.S., and C. F. Elam, on "The Distortion of an Aluminium Crystal during a Tensile Test."

ROYAL INSTITUTION OF GREAT BRITAIN.

ALBEMARLE STREET, PICCADILLY, W.1.

Saturday, February 17. — Sir ERNEST RUTHERFORD, LL.D., D.Sc., F.R.S., M.R.I., Prof. of Natural Philosophy, on *Atomic Projectiles and their Properties.* (Lecture I.)

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, THURSDAY, FEBRUARY 15, 1923, AT 8 P.M.

The following papers were read:—

Spinacene: Its Oxidation and decomposition.—A. CHASTON CHAPMAN.

Investigations on the dependence of rotatory power on chemical constitution. Part XIX.: *The rotatory and refractive dispersion of d-γ-nonyl nitrite.*—R. H. PICKARD and H. HUNTER.

Investigations on the dependence of rotatory power on chemical constitution. Part XX.: *The rotatory dispersive powers of oxygen compounds containing the secondary octyl radicle.*—H. HUNTER.

PHYSICAL SOCIETY OF LONDON.

PROCEEDINGS AT THE MEETING HELD ON JANUARY 26, 1923, AT THE IMPERIAL COLLEGE OF SCIENCE.—ALEXANDER RUSSELL, M.A., D.SC., IN THE CHAIR.

A paper on *A Supposed Relationship between Sunspot Frequency and the Potential*

Gradient of Atmospheric Electricity was read by Dr. C. Chree, F.R.S.

Abstract.

In a recent paper in *Terrestrial Magnetism*, Dr. L. A. Bauer draws the conclusion that both the range of the diurnal inequality of atmospheric electricity potential gradient and the mean value of the element for the year increase and diminish with sunspot frequency. This conclusion was based on observational data from the Ebro Observatory, Tortosa, Spain, between 1910 and 1920.

The present paper investigates the subject more mathematically, employing Kew electrical data from two periods of years, in addition to the Ebro data utilised by Dr. Bauer. Magnetic data from Kew Observatory for the same periods are similarly treated, so as to have parallel results from an element for which the sunspot relationship is generally admitted.

The results obtained are on the whole not incompatible with Dr. Bauer's conclusion, but they indicate that if a relationship of the kind supplied exists, the sunspot influence must be very much less in the case of atmospheric electricity than in that of terrestrial magnetism.

Discussion.

Dr. A. Russell, in expressing the thanks of the meeting for an interesting and instructive paper, said that few realise the very high value of the potential gradient which normally characterises their physical environment, and which may have important biological effects, not only in connection with electro-culture, but also in human psychology. The "correlation coefficient" which Dr. Chree introduced was not familiar to all physicists, and appeared to be of very great interest as a test of the inter-relation of different phenomena.

A paper on *A Further Improvement in the Sprengel Pump*, by J. J. Manley, M.A., Research Fellow, Magdalen College, Oxford, was taken as read in the absence of the author.

Abstract.

The paper relates to a further improvement in the pump described in the "Proceedings" of the Society, Vol. XXXIV., page 86, which is designed to avoid irregularities due to air skins on the inner surfaces of the apparatus. The present improvement consists in means for providing a mercury seal during periods when the pump is out of use, whereby the formation of fresh air skins is prevented.

A paper on *Null Methods of Measurement of Power Factor and Effective Resistance in Alternate Current Circuits by the Quadrant Electrometer*, was read by D. Owen, B.A., D.Sc., F.Inst.P., Sir John Cass Technical Institute, London.

Abstract.

Zero methods are proposed, and expressions derived, for the measurement of power factor and effective resistance of alternating current loads. The methods are extended to high tension circuits.

The effect of "electrical control" of the needle of the quadrant electrometer is discussed, and it is shown that the usual formula for the instrument is applicable only when the needle is maintained at its mechanical and electrical zero. The further advantages of null methods are emphasised.

Illustrative tests are recorded.

Discussion.

Dr. E. H. Rayner congratulated the author on his valuable additions to the many uses of the Quadrant Electrometer. This wonderful instrument was invented over half a century ago by Lord Kelvin, but was still unsurpassed in its utility, being applicable to the accurate measurement of power, insulation, phase-angles, and many other quantities. The speaker took the opportunity to point out some details as to which care is necessary in the practical use of the Electrometer. (1) With high voltages the mechanical force on the needle is considerable and may bend it, leading to inconsistent results at low power factors. (2) Referring to Fig. 1 of the paper, the high resistance *AO* generally has an appreciable distributed capacity, with the result that the voltage across *MO* is not in phase with the current. If conditions permit, the easiest remedy is to take as much current along *OA* as possible; for instance, if the current in this branch be 1/20 ampere, the power factor in a common case would be 0.1 or 0.2 per cent., but on increasing the current to 1 ampere the phase lag might become negligible. A similar error has to be contended with where a step-down transformer is used, as shown in Fig. 5, and it must be remembered that for small phase-angles an error of a few minutes of arc may represent a large percentage error. (3) An extremely

important point when high voltages are applied to the needle is that the faces of the quadrants should be perfectly flat. To this end they should be ground on cast iron after they have been fixed in place.

Mr. G. L. Addenbrooke referred to his papers published in the *Electrician* in 1901 as relevant to some of the points raised by the author. He added that it is convenient to arrange a switch whereby the point P, Fig. 1 of the paper, may be connected at will to the point O. In this way the instrument may be converted into an ammeter. He had used deflectional methods because they permitted "seeing what was going on."

Dr. A. Russell congratulated the author on discovering so many theorems and applying them so usefully, and expressed appreciation of Dr. Rayner's helpful suggestions.

Capt. R. Dunsheath (communicated): This paper is very opportune at the present time, when so many investigators are seeking the best method of measuring dielectric losses, and is full of useful suggestions. I do not agree with the author, however, that it is desirable to eliminate both voltmeter and ammeter. His methods give power factor only, but a figure for actual watts lost is generally required. Also, due to the importance of the dependence of power factor and losses on voltage, it is usual to decide at the commencement of a test what voltage shall be adopted, and a voltmeter is essential. The ammeter is not so necessary as, having V, N', and R, in formula (4), the value of the current follows at once. Proceeding in this manner $\cos \phi$ is obtainable without the use of the cumbrous equation (6). It is, of course, necessary to switch one side of the voltmeter from O to B, but this is a simple matter.

I notice that Dr. Owen estimates the error of the figure obtained for phase angle on a $1 \mu F$ condenser at about 16 per cent. Much smaller condensers than this are usual in certain branches of industrial work, and it would be interesting to know the sensitivity of the instrument used, and what sort of accuracy might be expected if the method were applied to capacities of the order of $0.01 \mu F$.

The author (in reply to the discussion): The remarks of Dr. Rayner will be valued by practical workers. The question of phase error in the shunt resistance, and methods of compensation have also been treated by Orlich and Schultze. Mr. Addenbrooke's desire to follow what was going on by watching the deflection was, of course, quite natural. In the present methods this could always be done in the preliminary tests by slipping P into coincidence with O (see Fig. 1); for the final reading the zero balance would confer a distinct gain in accuracy. In reply to Capt. Dunsheath's inquiry, the sensitivity of the electrometer used in the tests quoted was such that with 100 volts on the needle and one-tenth of a volt across the quadrants the deflection was about 60 mm. at a metre scale-distance. This could have been multiplied three or four times possibly. Measurements on a $0.01 \mu F$ condenser could be conducted with much the same accuracy as those with $1 \mu F$, since the resistance R could be increased in inverse proportio nto the capacity.

A Demonstration of an Electro-Capillary Relay for Wired Wireless was given by MAJOR C. E. PRINCE, O.B.E.

The relay is intended for use with a calling device in connection with high-frequency currents acting as carrier waves for telephony over power-mains. The high-frequency current is rectified and passed through a thread of mercury which is contained in a capillary tube, and is in contact at each end with a quantity of acid, platinum wires by which the current enters and leaves, being immersed in the latter. The passage of the current causes the mercury thread to move, and it was suggested many years ago by Wheatstone that this thread might be made to close an electric circuit; but practical difficulties prevented the successful application of the idea. In the present invention the capillary tube is arranged horizontally on a beam which, as soon as the mercury moves, over-balances in consequence of the weight of the latter and closes the circuit of a call bell or lamp. To prevent the evaporation of the acid the cups containing it are connected by a further capillary tube which serves to equalise the pressure, and the tube in which the mercury thread lies is widened at its middle point to form a chamber for the reception of bubbles and other obstructions which may have got into the tube before sealing.

The circuit arrangements make provision for the restoration of the mercury to its original position whether the call be answered or not. In series with the thread and with a rectifier is arranged a condenser in which the charge that has passed round

the circuit is stored, and after the call this charge is sent through the mercury and acid in the reverse direction. The required discharge is effected by contacts which short-circuit the rectifier when the switch-hook is raised, but if the call be unanswered the same result is produced more slowly by a high-resistance leak.

The instrument will respond to currents of 4 or 5 or even 2 microamperes, and will function during long periods without attention. Its sensibility was demonstrated by passing through it the voice-current from the secondary of a microphone transformer, and subsequently the current from a single dry cell in series with the body of the demonstrator. If the leak resistance be small enough Morse signals will fail to effect a call in consequence of the leakage which takes place during the intervals between the signal elements, while a series of long dashes will nevertheless be effective and can be used as a call signal.

The cause of the movement of the mercury is obscure, and the phenomenon is of some interest to physicists. The total movement appears to be proportional to the coulombs which pass, so that the arrangement might be used as a quantity meter for small currents, such as voice currents.

NOTICE TO FELLOWS.

Fellows who have not already done so are kindly requested to forward information in regard to change of address, or of title or degree, not later than MARCH 1 next to

Mr. F. E. SMITH, F.R.S.,
"Redcot," St. James's Avenue,
Hampton Hill, Middlesex.

ABSTRACTS OF THE PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF LONDON.

JANUARY 24, 1923, PROF. A. C. SEWARD, Sc.D., F.R.S., PRESIDENT, IN THE CHAIR.

The following communications were read:—

On Reptilian Remains from the Karroo Beds of East Africa, by SIDNEY HENRY HAUGHTON, B.A., D.Sc., F.G.S. (Read by Dr. A. Smith Woodward, F.R.S., Pres. L.S., F.G.S.)

Three specimens of a small fossil were found by Mr. F. P. Mennell, F.G.S., in black shale in the middle of Karroo Formation, near Tanga, on the coast of Tanganyika Territory. Two are well preserved, and are now described in detail. They represent a new genus and species of aquatic reptile, in general appearance much like *Mesosaurus*, but differing in its shorter neck, thinner ribs, relatively larger and more massive fore-limb, the presence of a large rounded sternum, and of only four distal carpal and tarsal bones instead of five. It is perhaps more closely related to *Youngina*, and may be regarded as an aquatic adaptation of that type. If so, the shale at Tanga is approximately of the same age as the Middle Beaufort Beds of South Africa.

Glacial Succession in the Thames Catchment-Basin, by the REV. CHARLES OVERY, M.A., F.G.S.

This paper is intended to establish a definitive succession-grouping for high-level gravels of the Thames catchment-basin, analogous to that adopted for the valley-gravels proper. The necessity for this arises from the present confused system of nomenclature, and the lack of correlation between different areas. It is indispensable to the establishment of the Glacial Succession.

The Kennet Stages of H. J. Osborne White are dealt with, and an analysis is given of the Plateau-Gravels of Oxfordshire: the grading of these with reference to river-level, establishes a simple correlation with the Kennet Stages.

The author advocates the adoption of a norm series with effective nomenclature for the Berkshire-Oxfordshire area: namely, P_{350}, P_{300}, P_{265}, P_{230}, P_{210}, P_{260}, P_{135}. If this norm series is represented in the Hampshire and London areas, succession-grouping, according to this scheme, possesses high significance.

Grading and analysis in the Hampshire and London areas result in the establishment of the norm series for the whole river-system. In this way light is thrown on such vexed questions as the age of the Goring Gap, the mode of description of the Plateau-Gravels, Glacial Succession in the Thames Pasin, and, finally, on the bearing of the distribution of Drift constituents on the history of the Thames river-system.

The author claims to furnish definite evidence for the course of the pre-Pleistocene Thames, for the continuity of the Evenlode, Goring Gap, Henley Gorge, Colne-Lea divide, and Essex-coast system. He is able to correlate the deposition stages with recognised Glacial Epochs, and con-

cludes with deductions as to the age and succession of the implementiferous gravels of the Thames and its tributaries.

BOROUGH POLYTECHNIC INSTITUTE.

Distribution of Prizes by The Attorney-General.

The Attorney-General, the Rt. Hon. Sir Douglas McGarel Hogg, P.C., K.C., M.P., distributed the prizes at the Borongh Polytechnic on Friday, February 2. The Chairman of the Governors (Mr. J. Leonard Spicer) presided. In introducing the Attorney-General, Mr. Spicer referred to the pleasure it gave all those connected with the work of polytechnics that in Sir Douglas Hogg they welcomed one whose whole life had passed in the polytechnic atmosphere and tradition. Sir Douglas Hogg's father, Mr. Quintin Hogg, had been the founder of the Polytechnic in Regent Street, and Sir Douglas himself had, throughout his life, been associated with that Institute.

Sir Douglas Hogg, in his address, after referring to the great loss suffered through the death of Lord Kinnaird by all those interested in the youth of London, described the origin and aims of the great polytechnic movement which had taken shape in the formation 30 years ago of such institutes as the Borough Polytechnic. With regard to the work of the Institute, he said it was not their desire to turn out a number of half-fledged amateurs to compete with the men in the workshops, but by technical instruction to enable those in the workshops to make themselves more efficient and to make greater progress in the industry to which they belonged. He was sure that the policy which had actuated the Governors in supplementing the experience of the workshop by this technical instruction was a sound one, as was the policy of selecting teachers who themselves had knowledge of their industries.

It was very good to see that the women's side of the Borough Polytechnic was so strong. Some of the activities of the Borough Polytechnic were unique in this part of England; the School of Bakery and Confectionery had no parallel in the South-Eastern Counties, and the Department of Painters' Oils, Colours and Varnishes represented a highly specialised and very valuable piece of technological work. The Borough Polytechnic was to be congratulated on the way in which it had enlisted the help of associations of employers, expert trade committees, trades unions, and associations of employers in order to keep its work closely related to the current needs of industry. In addition, however, to purely technical instruction, the social side of the Institute was a very strong one; it was concerned even more with the education of good citizens than with the production of expert craftsmen.

Principal Bispham, in his report, pointed out that both in quality and bulk the work of the session under review was a record one for the Institute, and an altogether worthy tribute to the former Principal, Mr. C. T. Millis, who had just retired.

Other speakers were Mr. F. A. Strauss, M.P., the Mayor of Southwark, Mr. D. Clifford Highton (Vice-Chairman of the Governors), Mr. P. M. Evans (Clerk of the Clothworkers' Company), and Mr. F. W. Mills (Chairman of the Students' Electoral Committee).

OBITUARY NOTES.

The Late Mr. W. Woolley, J.P., of Blackburn.

Great regret has been caused at Blackburn through the death of Mr. W. Woolley, J.P., of the Bungalow, Meins Road, in that town, at the age of 58 years. He was the head of the firm, J. Woolley, Ltd., manufacturing chemists, and had been seriously ill for a few weeks. In the hope of bringing about an improvement in his condition, two transfusions of blood were resorted to. In each of these cases his sons volunteered to undergo the operation, the last being only a few hours before Mr. Woolley's death, when the required quantity of blood was given by a younger son, Mr. Harold Woolley, who is at the Agricultural College, Preston.

Mr. W. Woolley's early life was spent in Preston. All his life he was connected with the Wesleyan body, and he filled all offices open to laymen in the circuit. He had also worked for and held responsible positions in relation to the Blackhurn Free Church Council, the Sunday School Union, and the Band of Hope Union. For six years he was a member of the Blackhurn Town Council. In November, 1916, he was made a Justice of the Peace for the Borough of Blackburn. He has left a widow and three sons.

Professor William von Röntgen, the discoverer of X-rays, has died at Munich at the age of seventy-eight.

Though a German, he was educated in Holland and Switzerland, taking his doctor's degree at Zurich in 1869.

After holding minor appointments, he settled at Wurzburg as Professor of Physics in 1885, and later became director of the Physical Institute, Munich, a post he resigned four years ago on account of advancing age. He applied mathematics to practically every branch of physics, and while at Wurzburg he discovered the Röntgen rays, or, as he called them because of their character, the X-rays. That epoch-making discovery was the result of a series of experiments he conducted in 1895 on the phenomena resulting from the passage of electricity through the vacuum tubes invented by Sir William Crookes. The tube was enclosed in an opaque case, and Röntgen was astonished to find that certain radiations from the tube passed through the case and caused a fluorescent effect on objects outside.

With the caution of the true scientist, Röntgen was in no hurry to announce his discovery, but concentrated on a long series of confirmatory experiments. More than a year later he felt justified in making public his sensational discovery.

His other physical researches are of interest mainly to scientists, but the discovery of the X-rays has assured his name a permanent place in the roll of those men of science who have wrested secrets from nature of inestimable value to the world at large.

GENERAL NOTES.

THE DETECTION AND ESTIMATION OF SMALL QUANTITIES OF ARSENIC.

JOINT MEETING OF THE SOCIETY OF PUBLIC ANALYSTS AND THE NOTTINGHAM SECTION OF THE SOCIETY OF CHEMICAL INDUSTRY.

For the first time in the history of the two Societies, a joint meeting of the Society of Public Analysts and of the Nottingham Section of the Society of Chemical Industry has been held. On January 17 more than 50 of the members of the Society of Public Analysts went to Nottingham to take part in the discussion on the methods of estimating arsenic, and were entertained at dinner by the local section prior to the discussion which took place in the Lecture Theatre of Nottingham University before a crowded audience.

The chair was taken by Mr. Burford, Chairman of the Nottingham Section, and the discussion was opened by Mr. A. Chaston Chapman, F.R.S., who described his experience during the last 25 years with the zinc-acid process, and gave an outline of his procedure, more particularly in the use of cadmium to render the zinc sensitive.

He was followed by Mr. Wilkie, Secretary of the Nottingham section, who demonstrated the use of his electrolytic method of estimating arsenic, in which the reversibility of the reaction was prevented.

The next speaker was Dr. Monier-Williams, who showed an electrolytic Marsh apparatus modified from that in use in the Government Laboratory.

Major Trotman was of the opinion that the preliminary treatment of the material was the crucial point of the estimation. He advocated the calling of a conference to discuss the standardisation of methods of estimating arsenic.

Mr. H. Droop Richmond attributed the want of sensitiveness of the zinc in the zinc-acid method to the presence of iron, and Mr. J. Webster described an experiment indicating that the total amount of arsenic in a large organ, such as the liver, was correctly estimated by multiplying the amount found by a factor.

Mr. Jenson, Dr. Dyer, and Mr. Weaver also joined in the discussion, and Mr. P. A. Ellis Richards (President), and Mr. E. R. Bolton (Secretary) expressed the thanks of the Society of Public Analysts for the hospitality which had been shown to them by the Nottingham section.

ROYAL INSTITUTION.

On Tuesday, February 13, at 3 o'clock, Professor A. C. Pearson delivered the first of two lectures at the Royal Institution on "Greek Civilisation and To-day": (1) "The Beginnings of Science"; (2) "Progress in the Arts." On Thursday, February 15, Professor B. Melvill Jones began a course of two lectures on "Recent Experiments in Aerial Surveying," and on Saturday, February 17, Sir Ernest Rutherford will commence a course of six lectures on "Atomic Projectiles and their Properties." The Friday evening discourse on February 16 will be delivered by Professor A. V. Hill

on "Muscular Exercise," and on February 23 by Professor A. S. Eddington on "The Interior of a Star."

A General Meeting of the members of the Royal Institution was held on February 5, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. The deaths of Lord Kinnaird and the Hon. R. C. Parsons, members, and of Professor G. Lemoine and G. Lunge, honorary members of the Institution, were reported, and resolutions of condolence with the families were passed. The special thanks of the members were returned to Dr. Ernest Clarke, for his donation of £100 to the Fund for the Promotion of Experimental Research, and to Sir Humphry Rolleston for his gift of Sir Humphry Davy's honorary diplomas. Mr. and Mrs. Macnab were elected members.

IRISH CHEMISTRY STUDENTS AT BIRMINGHAM.

Recently the Senate and Council of the University of Birmingham received a request from the Royal College of Science, Dublin, to make provision at Birmingham University for eight senior students of chemistry who wish to do laboratory work, the commandeering of their alma mater by the Free State authorities having made it impossible for them to complete their studies in Ireland. The necessary arrangements were made for their reception, and all of them are now working under the supervision of the Dean of the Faculty of Science in the Chemical Department at the new University buildings at Edgbaston. From an academic point of view the hard necessity which has compelled these gentlemen to cross St. George's Channel is to be deplored, but Midlanders will feel some satisfaction in the thought that it was their university which was selected by those competent to judge when the question of transmigration was considered.

At a meeting of the Council of the Institution of Electrical Engineers, held on February 1, the following resolution was passed:—

"That in view of the present state of trade and employment, the Council request members who place, or who advise upon the placing of orders, to specify, as far as practicable, that the plant and material ordered shall be of British manufacture."

NOTICES OF BOOKS.

Organic Chemistry, or the Chemistry of the Carbon Compounds, by VICTOR VON RICHTER, edited by PROF. R. ANSCHUTZ and DR. H. MEERWEIN. Vol. III. *Heterocyclic Compounds.* Translated from the Eleventh German Edition by E. E. FOURNIER D'ALBE, D.Sc., A.R.C.Sc. Pp. XVIII. + 326. London: Kegan Paul, Trench Trubner & Co., Ltd. 1923. Price 25s. net.

The publication of this volume on the heterocyclic organic compounds completes the translation of the eleventh German edition of *Richter*, which appeared in 1912.

There is undoubtedly a demand for this translation—long overdue—but it is very regrettable that the important work accomplished by many eminent workers since 1912 is missing from the latest edition of this widely-consulted compilation. This is very noticeable, for instance, in the section on Vegetable Alkaloids, which is by no means up-to-date.

Another exasperating feature of this edition is that references to the original memoirs of authors outside Germany are to the *Chemisches Zentralblatt*. Authors' names are also seldom given. The same applied to Vol. II., reviewed in *The Chemical News* (1922, CXXIV., 226), April 21.

Thus, in the present volume, the reference on p. 89 to Moureu and Lazennec's synthesis of pyrazolone is C. 1906, II., 434. Pyman's researches on histidine and Lusk's work on amino-acids are quoted in the same manner. Examples of this kind could be further multiplied.

The intention in the original, evidently, was to assist German readers, but it would surely have been worth while to introduce French, English, American, and other original references in this translation.

Apart from these drawbacks the volume, which is well indexed, will serve a useful purpose until it is superseded by a subsequent edition. J.G.F.D.

Seifen und Eiweisstoffe, von DR. MARTIN H. FISCHER unter Mitarbeit von G. D. MCLAUGHLIN und MARIAN O. HOOKER. Autorisierte Deutsche Ausgabe von DR. JOHANN MATULA. Pp. 188 + 37 plates. Dresden and Leipzig: Verlag von Theodor Steinkopff. 1922. Price 4s. 3d.

Dr. Matula's German translation of the

work of Dr. Fischer and his collaborators will bring to the notice of Central European scientists the researches and ideas of these American physical and biological chemists.

After an introduction on the preparation of soaps, the systems soap-water, soap-alcohol are considered, together with cases of colloidal soap solutions in non-aqueous solvents.

Then follows an account of colloidal phenomena in general, from which the author proceeds to the study of colloidal proteins, the behaviour of which he considers analogous.

The proteins and their derivatives have been investigated in this manner in order to arrive at a better understanding of their biological significance.

Part II. gives the author's version of the preparation of soaps from the standpoint of colloid chemistry, in which the hydration theory is supported.

In Part III. analogies are adduced between the behaviour of soaps and albuminates and organic tissues.

Part IV. is by way of a supplement, containing physico-chemical data of various series of acids of importance in soap-making.

So far as the reviewer is able to judge, the translation has been well done, and although the views expressed are not always those generally accepted and understood, this edition should be well received.

J.G.F.D.

New Patents.

This list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

901—Chemical & Metallurgical Corporation, Ltd.—Acid-resisting tanks, etc. Jan. 10.

1775—Phopal Produce Trust, Ltd.—Process for obtaining oxalic acid or its salts. Jan. 19.

1674—Clayton Aniline Co., Ltd.—Treatment of

836—Cowburn, A. W.—Production of concentrated sulphuric acid. Jan. 10.

734—Roucka, E.—Apparatus for measuring and transmitting values of physical or chemical quantities. Jan. 9.

1673—Alcock, H. E.—Manufacture of phosphoric acid. Jan. 18.

acetyl cellulose in alkaline liquids. Jan. 18.

1301—Frink, R. L.—Producing alumina and glass-making salts. Jan. 15.

1666—Nobel, L. A.—Process for removing nitrogen from metal and alloys. Jan. 18.

1630—Vautin, C. T. J.—Extraction of copper from its ores. Jan. 18.

1787—V.L. Oil Processes, Ltd. — Treatment of mineral oils. Jan. 19.

Specifications Published this Week.

190733—Barton, G. V., and Lead Products Syndicate, Ltd.—Apparatus for the manufacture of lead oxide.

190754—Foster, A. B.—Process of treating hydrocarbon oils and tars.

190923—Linde Air Products Co.—Process and apparatus for the separation of gaseous mixtures.

190961—Mueller, M. E.—Method of recovering hydrocyanic acid from gas.

191117—Howland, A.—Analysis, synthesis, arrangement, and notation of colours, and apparatus thereof.

191122—Abbott Laboratories.—Production of certain esters of aromatic acids.

191129—Adeltanado, L.—Manufacture of superphosphates and manure.

191167—Turner, W. L.—Manufacture of metals and metallic alloys by the aluminothermic process.

184760—Caspar, C. H.—Process of distilling and concentrating liquids.

191215—Dieterich, H.—Process of manufacturing oxide of barium.

191233—Soc. of Chemical Industry in Basle.—Manufacture of derivatives of Dihydroisoquinoline.

191305—Soc. of Chemical Industry in Basle.—Manufacture of azo-dyestuffs.

191318—Cross, R.—Process for converting hydrocarbon oils into oils of lower boiling point.

Abstract Published this Week.

Titanium dioxide; vanadium compounds.—Patent No. 189700.—Mr. E. E. Dutt, of 7, Vicarage Gate, Kensington, London, has developed a process for the treatment of the residues of certain bauxites after they have been first treated by the Bayer process for the production of titanium dioxide and vanadium compounds. The residues, after washing, are dissolved in hydrochloric acid to yield a solution containing about 100 grm. titanium chloride per litre. Any considerable excess of acid is then neutralised, the iron is reduced, and alkali acetate added to the solution in amount equal to one-tenth of the titanium chloride present. The solution is boiled to precipitate titanium dioxide, and almost completely neutralised. The filtrate is treated with barium salts to precipitate barium vanadate, which may be used in the preparation of other vanadium componnds.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3280.

SUBSTANCES DISSOLVED IN RAIN AND SNOW.

By H. S. J. FRIES.

Considerable interest has been shown throughout the country on the determination of the character and quantity of substances dissolved in rain and snow. The accompanying article is a continuation of the analyses of rain and snow, which has been carried on at Cornell College for a number of years.

The samples that were analysed were collected in enamelware pans near the centre of the town. The town of Mount Vernon is seventeen miles from Cedar Rapids, the nearest manufacturing centre, and the town itself has no industries of its own.

Forty-one samples of rain and snow were collected and analysed. During the period from September 19, 1921, to June 2, 1922, there was a total precipitation of 17.46 inches of rain, including snows. Twelve inches of snow were taken to equal one inch of rain.

The total pounds of nitrates per acre were 1.074. In order to determine the number of pounds of each substance that fell per acre, we took 226,000 pounds to be the weight of one inch of rain on one acre. We found there were 0.183 pounds of nitrites per acre. The total pounds of free ammonia per acre were 1.843. The total pounds of albuminoid ammonia per acre were 1.327. The precipitation of sulphates as SO_3 was 0.6919 pounds per acre. The total pounds of chlorine as chlorides was 7.042 per acre.

These analyses were carried on under ordinary laboratory conditions, at the same time avoiding unnecessary contamination during processes. The samples were analysed as soon after their collection as possible.

It is rather interesting to note that the rainfall during the latter part of October, and the latter part of February, was approximately the same, and the highest point reached in each month was exactly the same. Also, the rainfall during December and April was approximately the same, again reaching the same high point in waterfall This same phenomenon was again observed to be found for the months of November and March. The high point for these two months was 0.50 and 0.52 inches respectively.

Grateful acknowledgement is made of the kind assistance and suggestions of Dr. Nicholas Knight in carrying on this work.

Cornell College,
Mount Vernon, Iowa.
January 20, 1923.

A METHOD FOR THE NAMING OF ALL ORGANIC COMPOUNDS.

By T. Sherlock Wheeler, B.Sc., A.R.C.Sc.I., A.I.C.

The "structure line" system for representing the constitution of organic compounds, described by the author in *The Chemical News*, January 19 and 26, and February 2 (1923, CXXVI, 3275-6-7), is the basis of this new nomenclature system, and in describing the latter, the compounds I., II., III., etc., of the preceding article will be referred to by the same Roman numbers.

Compound I. (*Chemical News*, 1923, CXXV., p. 33) is on the "structure line" system represented by Ar. VI. 2, 3 IV. 2, 3 VI. 4, 5 VI. 2, 3 IV. and its derived name is hexar-2, 3-tetrar-2, 3-hexar -4, 5-hexar 2, 3-tetrar. The number of carbons in a ring shown by the Roman numerals in the representation is, in the name, replaced by the corresponding Greek number followed by "-ar." or "-al." respectively, according as the ring is aromatic or aliphatic. Chains are shown by adding "- an." to the Greek number corresponding to the barred Roman numeral indicating the chain. The termination is adopted because the barred Roman numerals represent fundamentally saturated hydrocarbon chains, and "an" is the usual termination for such chains.

All the rules for the representations apply to the names. Thus everything about a chain or ring comes in brackets immediately after its name; in the chain or ring are included all elements linked to two carbons, and these are shown by their names *before* the number of the place they occupy; the names of groups and elements attached to one carbon come *after* the number of that carbon. Double bonds are called "en" triple "in" as is usual. These syllables precede the number of the ele-

ment from which the double or triple bond starts. It is better not to incorporate these syllables in the chain name, as is done at present, because with several double and triple bonds confusion arises. *Branches in the structure line are, in the name, given after the names describing the main line*, dashes being used for identification purposes as before. The longest chain or ring system is the one along which, or through which, the structure line firs passes, and the main structure line is mad as long as possible. Also Latin number are always used to show recurrences o groups, elements, etc., in order to preven ambiguity with the Greek numbers, cis trans, and asymmetric compounds ar shown as in the representation system.

As the system of representation has beer fully described, the method of nomencla ture will be clear from the following:—

Number of Compound (in loc. cit.)	Representation.	Name.
II.	Ar. VI. (1-NO_2, 4-NH_2)2, 3 V. (4=H_2) 2, 3 V. (2=H_2) 3, 4 IV. (N-2).	Hexar-(1-nitro, 4-amino)-2, 3-pentar-(4 - bi-hydro-)-2, 3 pentar-(2-bi-hydro) -3, 4-tetrar-(nitrogen-2.)
III.	Ar. VI. 3, 4 VI.′ 2, 3 VI.″ 2, 3 VI.; 4′, 5′ VI.; 4″, 5″ VI.	Hexar-3, 4 - hexar′-2 3 - hexar″ - 2, 3-hexar; 4′, 5′ hexar; 4″ 5″ hexar.
IV.	Al. VI. 3 V.	Hexal-3-pental.
V.	Al. III. 2 $\overline{\text{IV.}}$′ 4 IV.; 2′ $\overline{\text{III.}}$ 3 V.; 3′ $\overline{\text{III.}}$ (3-Br.)	Trial - 2 - tetran′ - 4 - tetral; 2′ - trian - 3 pental; 3′ - trian - (3-bromo.)
VI.	$\overline{\text{IX.}}$′ 5 $\overline{\text{IV.}}$; 4′ $\overline{\text{III.}}$ (3-Cl.)	Nonan′-5-tetran; 4′-trian-(3-chloro.)
VII	$\overline{\text{IX.}}$ (0-3 N-7, 5-Cl, 9=0, 9-OH, Δ^7.)	Nonan-(oxygen-3, nitrogen-7, 5-chloro, 9-oxy, 9-hydroxy, en-7.)
VIII.	$\overline{\text{V.}}$ (S-3, 3=0.)	Pentar-(sulphur-3, 3-oxy.) (*Note*): Doubly-linked sulphur corresponding to "oxy" might be called "thio."
IX.	$\overline{\text{IX.}}$ ($\Delta^{5\ 8}$) 5 $\overline{\text{IV.}}$	Nonan-(bi-en-5 : 8)-5-tetran.
X.	Al. VI 2, 3 VI. 2, 5 $\overline{\text{III.}}$ (N-2, 2-Me.)	Hexal-2, 3-hexal-2, 5 trian-(nitrogen-2, 2-methyl.)
XI.	Al. VI. 1, 4 XIV.	Hexal-1, 4-tetradecal.
XII.	Ar. VI. 2, 3 VI. 5, 6 VI.	Hexar-2, 3-hexar-5, 6 hexar.
XIII.	Al. VI. 2, 3 VI. 5, 6 VI.	Hexal-2, 3-hexal-5, 6-hexal.
XII. (fully reduced)	Al. VI.′ 2, 3 VI. 5, 4′ $\overline{\text{V.}}$	Hexal′-2, 3 hexal-5, 4′-pentan.

Number of Compound (in loc. cit.)	Representation.	Name.
XIV.	$\overline{\text{IV}}$. (1.4 = $(OH)_2$, 1:4 $\equiv$ O_2 Δ^4, 1 trans 4.)	Tetran-(1:4-bi-hydro, 1:4-bi-oxy, en 2 1 trans 4.)
XV.	$\overline{\text{V}}$. (2-Br. trans 3 NO_2 Δ^2 or $\overline{\text{V}}$. ($\overset{+}{2}$-Br., $\overset{-}{3}$-NO_2 Δ^2).	Pentan-(2-bromo-trans 3-nitro, en 2) or Pentan-($\overset{+}{2}$ bromo, $\overset{-}{3}$ nitro en-2.)
XVI.	$\overline{\text{VI}}$. (2:3:5 $\equiv$ $\overset{+}{(OH)_3}$, 4- $\overset{-}{(OH)}$, 1:6 = $(OH)_2$) or $\overline{\text{VI}}$. ($\overset{+}{1}$:$\overset{+}{2}$:$\overset{-}{3}$:$\overset{+}{4}$:5:6 $\equiv$ (OH_6))	Hexan-(2:3:5-ter $\overset{+}{\text{hydroxy}}$, 4-$\overset{-}{\text{hydroxy}}$, 1:6-bi hydroxy.) or Hexan-($\overset{+}{1}$:$\overset{+}{2}$:$\overset{-}{3}$:$\overset{+}{4}$:5:6- sexi hydroxy.)
XVII.	$\overline{\text{IV}}$. ($\overset{+}{2}$-Cl $\overset{-}{3}$-Br Δ^2.	Tetran-($\overset{+}{2}$-chloro, $\overset{-}{3}$- bromo, en-2.)
XVIII. *Probable formula of cinchonine.*	Al. VI.′ (N-4) 4, 1 VI. 3, 3′ $\overline{\text{VI}}$. (0-4) 5 $\overline{\text{II}}$. 2 Ar. VI. (N-4) 5, 6 VI.	Hexal′-(nitrogen-4)-4, 1-hexal-3. 3′-hexan - (oxygen-4) - 5-dian - 2 - hexar -(nitrogen-4)-5, 6-hexar.

These examples given will suffice to show that the system can supply a systematic name *for any compound, no matter how* complex, provided its structure be known. It is fundamental in principle since taking no account of the classes of compounds, it names them simply on the basis of structure, chains or rings. It is especially suitable for abstracting, indexing and recording purposes; no longer will it be necessary to give the graphical formula of a compound after its name. It marks another advance in the writing of chemical formulæ which passed years ago from the old type system to the graphical linking system, and then stood still. The new method has the double advantage of enabling a compound to be named from its formula, or alternatively *the formula can be deduced from the* name.

In *The Chemical News*, 1921, CXXII., 122, the author put forward a logical scheme for the naming of the fundamental groups of organic chemistry. That scheme is very easily fitted into the above; it only necessitates an alteration in the terminations and in the names of some of the groups. *In the same paper are indicated* methods by which a new system, such as the above, could be introduced into the science of chemistry.

[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY, CORNELL UNIVERSITY.]

GERMANIUM. IV.—GERMANIUM TETRA-IODIDE.[1]

BY L. M. DENNIS AND F. E. HANCE.

(From the "Journal of the American Chemical Society," December, 1922.)

Winkler[2] prepared germanium tetraiodide by heating pulverulent germanium in vapour of iodine that was carried over the metal by a slow current of carbon di-

[1] *The investigation upon which this article is based was supported by a grant from the Heckscher Foundation for the Advancement of Research, established by August Heckscher at Cornell University.*

[2] *Winkler, J. prakt. Chem.*, CXLII (N.S. 34), 177, 1886.

oxide. He found it necessary to sublime the product repeatedly in carbon dioxide to remove free iodine. He describes the substance as highly hygroscopic, of orange colour, yellow when powdered, possessing a melting point of 144°, and appearing to boil between 350° and 400°. He gives the results of an analysis of the compound, and adds that L. F. Nilson found that germanium tetra-iodide did not dissociate up to 440°, but showed considerable dissociation at 658°.

The present investigation describes the preparation and further study of this substance.

Preparation.—Powdered, crystalline germanium was placed in alundum boats which were then inserted in a tube of Jena glass lying in an electric combustion furnace. A thermometer was laid in the combustion tube beside the boats. The portion of the tube projecting beyond the furnace was drawn down to small diameter at 7 points 10 cm. apart. Each constriction was packed with glass wool. Into the other end of the combustion tube was inserted the neck of a 500 cc. glass retort containing purified iodine. The tubulus of the retort was joined to an apparatus that supplied pure, dry carbon dioxide. An asbestos box was built around the retort, and this was heated from the outside to a temperature sufficiently high to keep the retort filled with vapour of iodine. The introduction of iodine into the combustion tube was regulated by the rate at which carbon dioxide was passed through the retort.

All air in the apparatus was first displaced by carbon dioxide, and then the retort and tube were gradually heated. Union of germanium and iodine began at 212°. When the temperature had risen to 250°, there appeared in the hot tube just before it emerged from the furnace a deposit of yellow and red crystals. At 360° very rapid combination of germanium and iodine took place, and the sublimate steadily increased until there had collected a considerable deposit of yellow crystals just beyond the boat, and beyond these a mass of orange-coloured crystals on the upper side of the tube and a ruby-red liquid along the bottom of the tube.

The operation was continued for 3 hours, and at intervals during the run the product that had formed was caused to sublime through the constrictions beyond the furnace by gently heating the tube with a Bunsen flame. It was noted, however, that as the substance was driven through the successive constrictions, its colour gradually changed from bright red (Mulliken's Colour Standard[3] R, Shade 2) to a chocolate-brown (R. O. Shade 2). Inasmuch as this change of colour indicates that the germanium tetra-iodide underwent decomposition when sublimed, the experiment was repeated with a tube that was not constricted, and the red liquid which collected just within and beyond the heated part of the combustion tube was allowed to cool in the tube at the end of the run, which was of 70 hours' duration. It solidified to a mass weighing about 50 g.

During this run there appeared on the walls of the tube, between the last boat and the red tetra-iodide, a deposit of light yellow crystals that were found to be germanous iodide, GeI_2. The crystals were of the hexagonal system with external angles of 120°. The compound will be fully described in a later article.

Analysis.—Portions of the red product were weighed in porcelain crucibles and were moistened with water. Conc. nitric acid was added, and the contents of each crucible was evaporated to dryness on steam cup. A few drops of conc. sulphuric acid were added, the acid was carefully fumed off, and the crucible was then heated to about 900°. The residual germanium dioxide was then weighed.

For the determination of iodine, samples were dissolved in water, 0.1 *N* solution of silver nitrate was slowly added, and the liquid was vigorously shaken until the yellow precipitate collected and the supernatant liquid became clear. About 3 cc. of conc. nitric acid and a few cc. of a solution of ammonium ferri-alum were then added and the excess of silver was titrated with potassium thiocyanate solution.

Wt. of GeI_4	Wt. of Ge		Wt. of I	
	Calc.	Found	Calc.	Found
G.	G.	G.	G.	G.
0.1975	0.02468	0.0243	......	......
1.0856	0.13565	0.1357	......	......
0.1790	0.02237	0.0225	......	......
0.1329	0.0166	0.0165	......	......
0.2015	......	......	0.1763	0.1761
0.2067	......	......	0.1809	0.1807

Melting Point.—The measurements were de with a "Tycos" Precision Thermo- ter, nitrogen filled, range 100° to 155°. e apparatus was that described by nnis,[4] which was filled with conc. sul- uric acid. The sample was placed in a all melting-point tube that was attached the thermometer, and the sulphuric acid s then heated at such rate as to cause a e of 1° per minute. The yellow, pow- red, germanium tetra-iodide assumed an ange tint as the temperature rose, and 132° it became deep red in colour. It lted sharply to a ruby-coloured liquid at 4°. Repetition of the experiment gave same result as did a third determina- n in which was employed an Anschütz ermometer that had been corrected by Bureau of Standards.

Crystal Form.—A crystallographic ex- mination of the substance was kindly de for us by Professor A. C. Gill, of the partment of Mineralogy. The crystals re prepared by slow and careful sublima- n in a current of dry, warm air. They re found to be regular octahedrons; the one angles were 60°, indicating that they long to the regular system. The crystals owed no double refraction.

Specific Gravity.—In searching for a quid medium in which the specific gravity germanium tetra-iodide might be deter- ined, its behaviour toward more than 20 organic or organic liquids was investi- ated. In every case the substance was ssolved or decomposed by the liquid. (See hemical Properties.)

Since the tetrachloride and tetrabromide germanium had been found to be un- fected by conc. sulphuric acid at room mperature,[5] the behaviour of the tetra- dide toward this acid was examined, and was found that at room temperature no isible change could be observed in the ubstance after submersion in the acid for 4 hours. Consequently, conc. sulphuric cid was used in the determination of the pecific gravity of the compound. Pure ermanium tetra-iodide was prepared in the orm of pellets by spreading the powdered ubstance along the inside of a long tube of Jena glass and melting it in a partial vacuum. The temperature was kept below 150°. When the compound melted, it coalesced into small globules about 3 mm. in diameter. A pycnometer of 5 cc. capa- city was weighed, was then half filled with the pellets of the tetra-iodide, and was again weighed. Conc. sulphuric acid was now run in until the sample was completely covered, and the air occluded in the pyc- nometer was then removed by placing the bottle in a vacuum desiccator and exhaust- ing the air. The pycnometer was then filled with sulphuric acid and was again weighed. The specific gravity of the sul- phuric acid at the same temperature was determined with the same pycnometer. Two determinations at 26° gave 4.322 and 4.321. Hence $d^{26°}_{26°} = 4.3215$.

Colour of Germanium Tetra-iodide.—At room temperature, fused germanium tetra- iodide in lump form is of the colour of coral, the precise shade being "O. R. Nor- mal."[6] When powdered, it has an orange colour "O. Y. Normal."

The compound in lump form shows at various temperatures the colours listed below.

Temp.	Colour.	Mulliken.
−185°	Canary-yellow	O.
− 50°	Buff	Y.O.
− 10°	Orange	O.Y.
+ 35°	Salmon	Y.
+ 50°	Brick-red	O.R.
+ 90°	Red	R.
+144°	Ruby-red	R.O.

Sublimation of Germanium Tetra-iodide. —About 5 g. of the substance was placed in a test-tube; in the neck of the tube was inserted a cork that carried a thermometer and inlet and outlet tubes of glass. The test-tube was immersed in an oil-bath, and a slow current of dry air was passed through the tube. The oil was slowly heated. At 110° a yellow vapour appeared in the upper portion of the tube, and as the temperature rose beyond this point a finely crystalline, yellow powder collected on the tube wall. When the tetra-iodide had reached a temperature slightly above its melting point (144°), sublimation was rapid. The heating was then stopped, and the tube was allowed to cool slowly. At the conclusion of the experiment a mass of quite large, orange-coloured crystals had collected on the stem of the thermometer

[3] *Mulliken, "Identification of Pure Or- anic Compounds," John Wiley and Sons,* 903, Vol. I.

[4] *Dennis, J. Ind. Eng. Chem.,* 1920, XII., 366.

[5] *See Dennis and Hance, Jour. Amer. Chem. Soc.,* 1922, XLIV., 299.

[6] *Mulliken's Colour Standards. Ref. 3.*

and the unsublimed residue in the tube was of ruby-red colour. It is thus apparent that when germanium tetra-iodide is carefully heated *in a current of air to a temperature* but slightly above its melting point it sublimes without decomposition.

Nilson and Pettersson have stated[7] that the compound "exists undecomposed in the gaseous condition at 440° but dissociates at higher temperature." They base this statement upon the result of a determination of the vapour density of the compound when it was volatilised at 440° (vapour of sulphur). They obtained a vapour density of 20.46, the theoretical vapour density being 20.0. Our observations during the preparation of germanium tetra-iodide seemed, however, to indicate that the compound is dissociated when heated to temperatures appreciably above its melting point. To gain definite information upon this question glass tubes 1 m. long and 10 mm. wide were sealed at the lower end and were inserted in vertical position into an electric heating furnace to a distance of 20 cm. The tubes were then heated to a temperature of 445°, and a small open tube containing germanium tetra-iodide was dropped into each. In a few minutes a *reddish brown vapour appeared in the long* tubes just above the top of the electric furnace, and shortly thereafter dark-coloured crystals were deposited on the inner walls of the tube at a distance of about 8 cm. above the top of the furnace. The heating was continued or some time at a temperature between 442° and 448°. and the tubes were then cooled and removed from the furnace. The crystalline deposit 8 cm. above the furnace was identified as free iodine. Just at the top of the furnace there was a deposit of yellow crystals, which proved to be germanium tetra-iodide. Midway between the bottom of the tube and the top of the furnace there was a deposit of canary-yellow crystalline plates of germanium di-iodide.

A small quantity of germanium tetra-iodide was placed in a tube of Jena glass which was then sealed and was gradually heated in an electric combustion furnace to a temperature of 440°. Dissociation resulted, and iodine amounting to over 5 per cent. of the weight of the tetra-iodide was set free.

(*To be continued.*)

[7] *Nilson and Pettersson, Z. physik. Chem.*, 887, I., 36.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, FEBRUARY 15, 1923, AT 4.30 P.

Papers read:—

E. R. SPEYER.—*Researches upon t Larch Chermes (Cnaphalopes strobilobii Kalt.), and their Bearing upon the Evo tion of the Chermesinæ in general.* Co municated by Prof. G. C. Bourne, F.R.S

(1) An alternation of form is the norm course of biological development in *Chermesinæ.*

(2) This alternation breaks down at certain point in the life-cycle of *Cnapl lopes strobilobius*, Kalt., the numerical p portions of one form to another produc *in the same generation showing the per* at which failure in the alternating mech ism takes place.

(3) The *Progrediens* type of *Cnaphalo strobilobius*, Kalt., is potentially a wing form, and is not a true dimorphism of Sistens type. This applies also to *Chermesinæ* in which either or both of th types occur.

(4) The *Sexuales* are different morp logically from all other generations. T are held to be a new production in evo tion.

(5) Species which are purely parthe genetic have ceased to develop from an e lutionary point of view, and show the pr able course of evolution in the vari genera.

(6) Migration from one species of Con to another is responsible for a duplica in the series of form-alternating, parthe genetic generations; the series upon Conifer has become morphologically dif ent from that on the other through action of natural selection in two differ environments.

(7) In existing species with two h plants, that portion of the cycle which r takes place upon the definitive host-pla has arisen through a stimulus given by recent return to sexuality, this account for the linking up of the two cycles an duplication of the series of parthenogen generations.

(8) Under these circumstances theories of "parallel series" and "p morphy" become obsolete.

G. V. ANREP.—*The Irradiation of Con tioned Reflexes.* Communicated by P E. H. Starling, F.R.S.

The experiments were performed with tactile conditioned reflexes, the parotid gland being taken as the effector organ. The following facts were established:—

(1) The tactile reflexes established on one side of the animal irradiate without a measurable decrement into the other side of the animal.

(2) There is a progressive decrement in the conditioned reflex during its irradiation over each of the two sides of the animal.

(3) The conditioned inhibition is in broad limits a cruder form of inhibition than the differential inhibition.

(4) The irradiation of the conditioned inhibition follows in the main lines the rules established for the irradiation of the differential inhibition and that of the reflex itself.

(5) The inhibitory processes previously established are temporarily inhibited during the development of a new inhibition.

(6) The short trace reflexes take an intermediate position between the simultaneous and the long trace reflexes.

PAPERS READ IN TITLE ONLY.

M. DIXON and H. E. TUNNICLIFFE.—*The Oxidation of Reduced Gluthathione and other Sulphydryl Compounds.* Communicated by Prof. F. G. Hopkins, F.R.S.

(1) A study has been made of the sulphydryl compounds: reduced gluthathione, cystein and thioglycollic acid. The reduction of methylene blue by these is in each case an autocatalytic reaction.

(2) The active agent producing this catalysis is the disulphide form R . S . S . R. All the disulphides studied possess the power of catalysing the reduction by each of the sulphydryl compounds.

(3) Evidence is advanced in support of the hypothesis that a more active addition compound of R . SH with $R^1 . S . S . R^1$ is formed.

(4) It is shown by three methods that the disulphide compounds also catalyse the oxidation of the sulphydryl compounds by atmospheric oxygen. The form of the reaction curves is not autocatalytic, but an explanation for this is suggested.

(5) The reaction velocity in the cases of glutathione and cystein shows a sharp optimum at a pH of 7.4. Thioglycollic acid does not show this.

(6) The influence of various factors on the reaction is described.

(7) The bearing of these results on the conception of the function of glutathione and related compounds in tissue oxidation processes is discussed.

J. C. BRAMWELL, R. J. S. MCDOWALL, and B. A. MCSWINEY.—*The Variation of Arterial Elasticity with Blood Pressure in Man.* Communicated by Prof. A. V. Hill, F.R.S.

A method is described by which the extensibility of an artery in living man may be measured at all internal pressures up to the diastolic pressure. As in the case of an isolated artery, the extensibility decreases as the internal pressure is increased.

L. J. HARRIS.—*On the Existence of an Unidentified Sulphur Grouping in the Protein Molecule.* Part I.—*On the Denaturation of Proteins.* Part II.—*On the Estimation of Cystine in certain Proteins.* Communicated by Prof. F. G. Hopkins, F.R.S.

Results obtained by many workers in the past point to the existence of an undiscovered sulphur linkage in certain proteins.

A study has been made of the conditions under which the grouping reactive to nitroprusside is liberated from ovalbumin and other proteins, and of its survival in the proteose, peptone and polypeptide molecule.

The production of this reactive group is an essential feature of the denaturation of ovalbumin and certain other proteins.

The chemical nature of precipitation, denaturation, and coagulation is discussed.

It is suggested that the nitroprusside reaction, attributed by Arnold to cystein may be due to the presence of a grouping of the thiopeptide type.

A new method has been employed for the gravimetric estimation of cystine in proteins. The results indicate that whereas in serum albumen the cystine accounts for no less than 89 per cent. of the total sulphur content, in ovalbumin 86 per cent. of the sulphur still remains to be accounted for.

Preliminary work has been started on the isolation of sulphur bodies from the degradation products of protein.

N. B. LAUGHTON.—*Reflex Contractions of the Cruralis Muscle in the Decerebrate and Spinal Frog.* Communicated by Sir Charles Sherrington, P.R.S.

(1) In the decerebrate frog there was a prolonged tonic after-effect in the contraction of the cruralis muscle on reflex stimulation of the ipsilateral sciatic nerve. No such tonic effect was observed in the cruralis muscle of the spinal preparation on stimulation of the same nerve.

(2) A shorter latent period and a more rapid increment of height were marked in the spinal preparations.

(3) During spinal shock the height of the reflex contraction in the spinal frog is not maximal.

(4) In 50 per cent. of the experiments the height of the myogram was greater in the decerebrate than in the spinal preparations. In the other 50 per cent. of the experiments, the height of the contractions was greater in the spinal than in the decerebrate frogs.

The Bakerian Lecture was delivered on Thursday, February 22, at 4.30 p.m., by G. I. TAYLOR, F.R.S., and C. F. ELAM, on *The Distortion of an Aluminium Crystal during a Tensile Test.*

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The Annual General Meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, February 7, when the President, Mr. P. A. Ellis Richards, delivered his annual address.

The following were elected as Officers and Council for the ensuing year:—

President: P. A. Ellis Richards.

Past-Presidents, Serving on the Council (Limited by the Society's Articles of Association to 8 in number): Leonard Archbutt, A. Chaston Chapman, Bernard Dyer, Otto Hehner, Samuel Rideal, Alfred Smetham, E. W. Voelcker, J. Augustus Voelcker.

Vice-Presidents: F. W. F. Arnaud, F. H. Carr, G. W. Monier-Williams.

Hon. Treasurer: Edward Hinks.

Hon. Secretary: E. Richards Bolton.

Assistant Hon. Secretary: R. G. Pelly.

Other Members of Council: H. Ballantyne, S. F. Burford, S. Elliott, B. S. Evans, E. M. Hawkins, Harri Heap, H. F. E. Hulton, Andrew More, A. E. Parkes, W. R. Schoeller, G. R. Thompson, J. F. Tocher.

At the Ordinary Meeting on February 7, 1923, held at the Chemical Society's Rooms, Mr. P. A. Ellis Richards (President) in the chair, certificates were read for the first time in favour of:—Messrs. Joseph John Backes, A.R.C.Sc., A.I.C., D.I.C., Samuel Gordon Stevenson, A.I.C., Richard William Sutton, B.Sc.Tech. (Manch.), A.I.C., Laurence Barnett Timmis, M.Sc.Tech. (Manch.), A.I.C., Alfred Edward Johnson, B.Sc. (Lond.), F.I.C., A.R.C.S.I., Ernest Victor Jones, F.I.C., Francis Keneh Donovan, B.Sc. (Lond.).

Certificates were read for the secon time in favour of:—Messrs. George Hen Appleyard, F.I.C., James Walter Blac B.Sc. (Lond.), Arthur William Stare A.R.C.S., B.Sc., A.I.C., John Matthe Wilkie, B.Sc. (Lond.), F.I.C.

The following were elected members the Society:—Messrs. Henry Aldous Bro ley, Walter Horace Clulow, William Ple derleith Lewellen Hope, B.Sc. (Edin A.I.C., Robert Faraday Innes, F.I.C Osman Jones, F.I.C., Alan West Stewa D.Sc. (Brux.), A.I.C., William Heat Thorns.

The following papers were read:—

Notes on the Examination of Preserv Meats, etc., by OSMAN JONES, F.I.C.

Titanium in Nile Silt, by E. GRIFFIT JONES.

ABSTRACTS.

Notes on the Examination of Preser Meats, etc., by OSMAN JONES, F.I.C. T author stated that the presence of a tr of zinc chloride in the tin container (wh sometimes arises through the use of t salt as a soldering flux) caused a m rapid absorption of tin by the food c tents, and that the use of sealing fl containing a high boiling point solv caused a disagreeable flavour to be parted to the food material. Methods the detection of such a solvent were giv The absorption of tin by the meat conte of a can was found to be the greatest the time of processing and almost to ce after about four months. The author mentioned a test for Agar in the prese of gelatine: a dilute solution of iodin potassium iodide gives a crimson co with Agar, while with gelatine an ora coloured precipitate is produced.

Titanium in Nile Silt, by E. GRIFFIT JONES. The author has examined silts f various parts of the Nile, and determi the Titanium by a colorimetric met after freeing the sample from si Amounts varying from 1.3 to 2.55 per c of titanium oxide on the dried silt found, but an examination of Egyp straw, a likely source of titanium, showed 0.4 per cent. of titanium oxid the ash.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Paper read at the Royal Society of Arts n Tuesday, February 13, 1923, at 5.30 .m.:

Some Practical Notes on Oil Pumping, y G. W. E. GIBSON, Member "Koninklijk nstituut van Ingenieurs" (The Hague), Iember "Société de Chemie Industrielle" Paris).

ROYAL INSTITUTION OF GREAT BRITAIN.

Saturday, February 24.—SIR ERNEST UTHERFORD, LL.D., D.Sc., F.R.S., I.R.I., Prof. of Natural Philosophy, will eliver his second lecture on *Atomic Proctiles and their Properties.*

THE CHEMICAL SOCIETY.

On Thursday, February 22, 1923, at 8 .m., at the Institution of Mechanical ngineers, Storey's Gate, S.W.1, Princial J. C. IRVINE, C.B.E., F.R.S., delivered s lecture, entitled, *Some Constitutional roblems of Carbo-Hydrate Chemistry.*

At the Ordinary Scientific Meeting of e Chemical Society on Thursday, Febary 15, in addition to the papers anounced or reading, Dr. A. Scott, F.R.S., ade a statement with reference to his instigations on "The Oxide of a New Element" (see *The Chemical News*, this vol., 81).

He announced that Coster and Hevesy d found no trace of Hafnium in the samees of sand which he had submitted to em for examination.

Bohr, however, stated that from his ectrum analysis he foun dlines which did t correspond with any known element.

It is thus possible that two new elements ve been discovered.

THE INSTITUTE OF METALS.

The Annual General Meeting of the Intute of Metals will be held, by kind perssion, in the house of the Institution of echanical Engineers, Storey's Gate, estminster, S.W.1, on Wednesday and ursday, March 7th and 8th, 1923. The eting will commence at 10 a.m. each y, concluding not later than 5 p.m. On rch 7th the annual dinner of the Institute will be held at the Trocadero Restaurant, Piccadilly Circus, W.1, at 7.30 for t p.m.

May Lecture.

After the Annual General Meeting the next gathering of members will take place, as previously announced, on Wednesday May 2, at the Institution of Mechanica Engineers, at 8 p.m., when DR. W. ROSENHAIN, F.R.S., will deliver the annual May lecture, his subject being, *The Inner Structure of Alloys.*

Annual Autumn Meeting.

The Annual Autumn Meeting of the Institute will be held at Manchester in September. Further announcements regarding both the above meetings will be made at a later date.

INSTITUTION OF ELECTRICAL ENGINEERS.

An extra meeting was held on Thursday, February 22, 1923, at 6 p.m., when DR. H. W. NICHOLS delivered a lecture on *Trans-oceanic Wireless Telephony*, followed by a discussion. Mr. B. Welbourn exhibited two cinematograph films on "The Electrification of the Chicago, Milwaukee and St. Paul Railroad Company."

ROYAL MICROSCOPICAL SOCIETY.

A meeting of the Society was held on Wednesday, February 21, at 7.45 p.m. The following papers were read and discussed:

PROF. SIR WILLIAM MADDOCK BAYLISS, D.Sc., F.R.S., F.R.M.S.: *Microscopical Staining and Colloids.*

MR. A. MALLOCK, F.R.S.: *Note on the Resolving Power and Definition of Optical Instruments.*

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society was held in Armstrong College, Newcastle-upon-Tyne, on Wednesday, February 21, 1923.

The following papers were read:—

Organising for Production from Pot Furnaces, by W. W. WARREN, A.M.I.C.E., A.M.I.E.E.

The Effect of Boric Oxide on the Melting and Working of Glass, by F. W. HOPKIN, B.Sc., and PROF. W. E. S. TURNER, D.Sc.

Some Physical Properties of Boric Oxide-Containing Glasses, by VIOLET DIMBLEBY, B.Sc., S. ENGLISH, M.Sc., and PROF. W. E. S. TURNER, D.Sc.

By the courtesy of the Directors, a visit has been arranged to the works of Messrs. Lemington Glass Works, Ltd., Lemington-on-Tyne, on Wednesday morning, Feb. 21, 1923. The works are engaged in the manufacture of electric lamp bulbs and tubing, the former both by hand and by machine. The furnaces include a recently-installed 10 pot Hermansen Recuperative Furnace. A 24-arm Westlake bulb machine is in operation.

FUEL PROBLEMS.

On February 6, an open meeting of the Birmingham and Midland Section of the Society of Chemical Industry was held at the University of Birmingham, on "Fuel Problems." Dr. E.B. Maxted, Chairman of the Section, who presided, pointed to the close relationship of fuel and fuel problems to the chemical industry. From a national standpoint our aim should, he said, be to make most effective the utilisation of coal.

Mr. Edgar C. Evans, F.I.C. (London) emphasised the need for fuel problems being considered from a national standpoint. Although our coalfields were geographically crowded together in a very small area, it was a matter for surprise that so few attempts had been made to co-ordinate coalfield problems. Work was being done in the various research laboratories of the country on the constitution of coal, and work had been and was being done at individual collieries, on the particular problems of those collieries, but very little had been achieved towards co-ordinating the mass of individual work available, and drafting in general terms a scheme of research, a method of attack which would be national and not local in its respects. There was necessity for the production throughout the country of a standard blast furnace coke. He believed that the problem of excessive moisture in coke would eventually be solved by the adoption of continuous vertical retorts in which the coke would be evolved inside the oven, so that the only moisture in the material when it reached the furnaces would be that picked up *en route*. The sulphur question was becoming acute in some coalfields. In certain cases, supplies of high-class coking coal free from sulphur were getting very scarce, and any method of removing it from the remaining seams would be extremely valuable. Sulphur could exist in coal, in one or other of three forms—as pyrites, as organic sulphur and as inorganic sulphur. If it existed as pyrite sulphur it could be reduced very often by crushing the coal to a 10 or 20 mesh size and treating it in a fine coal cleaning plant. In some cases organic sulphur could be very largely reduced by fractional distillations in a current of steam. He had made a large number of tests on different coals in a small retort of about 1 ton a day capacity, in which carbonisation of the coal was effected in a current of superheated inert gas. In some cases where steam was used as the heating medium, considerable reduction of the sulphur content had been effected, but in other instances no improvement whatever took place. There was an enormous opening for smokeless fuel production on a big scale in England, and the gas industry was logically the one that should take up the question. As an example of the possibilities to the gas industry of the preliminary treatment of coal, he cited the following test:—1 ton of coal at 750° C. gave: 70 per cent. of coke containing 5 per cent. of volatiles of a free burning character; 53 to 54 lbs. of sulphate of ammonia; 15 gals. of tar; 4 gals. of light oil; and 17,000 to 18,000 c.f. of gas, of a calorific value of 437 B.T.U.s per cubic foot, the gas not containing more than 10 per cent. of CO. A high yield was not inconsistent with a low carbonising temperature and the production of a high-class smokeless fuel. A national view-point would go a long way, said Mr. Evans, to clear up some great difficulties. The question was primarily one of co-ordination of the research of the country. A chain of research stations was required at the various coalfields; each should specialise in its own problems. Coal owners and iron and steel manufacturers should be on the governing body of the stations, and there should also be gas engineers and fuel consumers. The work should be linked up with that of the universities, and he suggested that the Fuel Research Board should be the central body and co-ordinate researches into a general policy.

Dr. E. W. Smith (F.I.C.), London, said he was of the opinion that gas undertakings should not only supply suitable gas at a low price, but should develop the produc-

tion and sale of smokeless, free burning solid fuel, suitable for domestic and industrial purposes. The net value of the coke available for sale on a gas works was very little different from the net value of the gas made on the works. It was, therefore, well worth while improving the quality of this so-called "by-product," and enhancing its value as much as possible. A number of undertakings certainly did screen and grade their coke, and keep the water content down to a reasonable figure, but more could very well be done. There is room for much to be done in this direction. There was a growing public feeling that "smoke" must eventually be eliminated. All types of coal should be made available for the production of gas and smokeless solid free burning fuel. How could this be attained? By: (1) Coal cleaning; (2) coal blending; (3) coal briquetting; (4) coal briquette carbonisation, and the production of gas and free burning smokeless briquettes. This would be done, and the cycle of operations would be made to pay as compared with present gas works' methods.

Dr. Smith expressed surprise at the action taken by somebody in raising the CO bogie in a newspaper correspondence. The net result of the newspaper stunt had been an increase in the number of people who preferred the "gas way" to end their lives. Ignorance was at the bottom of much of this outcry. It was well that the gas industry was well established, otherwise when it was found that wireless enthusiasts were courting dangers of explosions and fires by earthing their equipments to gas pipes, somebody might demand an inquiry by unbiased men of the highest scientific attainments to advise the Board of Trade whether it was any longer safe for gas to be distributed in houses in iron pipes. It had not been shown that there had been during the last year more accidental deaths from CO poisoning than previously; accidental gas poisoning cases were not more prevalent in districts where the CO was high than where the CO was low, and it had been shown that there was no more CO in towns' gas generally at any time during the last 15 years. Whilst it was important to increase the efficiency of production of fuel, it was more important to increase the efficiency of the utilisation of fuel. That had been done in connection with lighting and gas fires, but much more required to be done in connection with industrial heating furnaces, and in regard to these he advocated further research work as to insulating materials, conductivity of refractories, the best means of attaining flame temperatures, the value and limits of regeneration, the relative values of radiant heat and thermal efficiencies of standard types of furnaces in use. He believed that the prosecution of such a research would amply repay the Institution of Gas Engineers.

An interesting discussion followed.

UNION OF SOUTH AFRICA—DEPARTMENT OF AGRICULTURE.

REPORT OF THE DIVISION OF CHEMISTRY FOR THE YEAR ENDED 30TH JUNE, 1922.

Chief of Division: Chas. F. Juritz, M.A. D.Sc., F.I.C.

1. *Organisation.*—The most important function of the year has been that of laying foundations for the closer co-operation of the sections of the Division located in various parts of the Union. This cannot be achieved all at once, but a few select phases of work will be brought into line step by step. Some of these will be enumerated later on. The guiding principle has been the resolution adopted at a conference called by the Secretary for Agriculture of heads of divisions and principals of agricultural schools (shortly before the twelve months under report), viz., that the *control and guidance of research work* should be vested in the chiefs of divisions, and that the services of the technical officers (*i.e.*, in this case the chemists) at the schools should be utilised to the greatest extent possible to assist the heads of divisions. The relations between the *chemists at the schools and the Chief of* the Division in regard to research work would therefore rest upon the basic principle that the former should act in a directive capacity, in consultation with the principal of the school concerned, in respect of any work to be carried out by any particular chemist.

At Grootfontein the Division has in Mr. A. Stead an officer of its own: he advises the principal on matters pertaining to the school's chemical section, and in return the school laboratories are at his disposal for the purposes of the Division. On the other hand, *the chemist belonging to the* school staff assists in the work of the Divi-

sion as far as possible, subsidiarily to the exigencies of the school's own requirements. On this basis the relations between the various chemical laboratories of the Department have been made closer, but a further rapprochement will be needed before a coherent unit is evolved. Meanwhile, consolidation is being proceeded with first where most urgently needed.

The Pretoria laboratory is wholly under the control of the Division. A great deal of the work there carried on hitherto has consisted of soil investigation.

The greatest difficulty is in regard to research work. There the supervision of the Chief of the Division embraces the laboratories attached to the schools as well as those directly connected with the Division. The fullest and most willing co-operation from principals and chemists is given in the endeavours to bring about co-ordination, but development must not be forced. At present measures are taken continuously to inform each institution of the progress of research work at every one of the others. This makes for mutual interest and solidarity of aim. Several problems have arisen and have been dealt with in a satisfactory and uniform manner, that previously would either have been disposed of as the individual institution first confronted therewith thought fit, or left in abeyance until a chemists' conference could consider it.

With the important matter of the agricultural soil survey of the Union little progress has been made. It is impossible for the Chief of the Division to give the survey the undivided attention which is essential, and Mr. Stead, Senior Chemist of the Division, who was placed in charge thereof, was prevented by other duties and prolonged illness from assuming that charge. The work will, it is confidently hoped, soon be commenced.

2. *Commission Work.*—During the year the Chief of the Division served on committees appointed to investigate the problems arising from the need of cheap industrial alcohol, and to inquire into the matter of the destruction of prickly-pear.

From October, 1920, until well into the year under report, Mr. Stead was virtually seconded for service as a member of the Drought Commission. The first-hand knowledge of the country and its problems and conditions gained in the course of this inquiry should prove of great value to the Division.

3. *Publications.*—The following papers by officers of the Division were published during the twelve months:—

A. Stead:
"The Value of the Paddock System," *Journ. Dept. Agric.*, Vol. III., No. 2, August, 1921, pp. 131-135.

B. J. Smit:
"Representative Transvaal Soils: The Norite Black Turf," *Journ. Dept. Agric.*, Vol. II., No. 4, October, 1921, pp. 337-342.
"The Uses of Tobacco Waste," *Journ. Dept. Agric.*, Vol. IV., No. 3, March, 1922, pp. 267-271.

C. F. Juritz:
"The Nicotine-Content of South African Tobacco," *Journ. Dept. Agric.*, Vol. IV., No. 6, June, 1922, pp. 552-562.
"The Submarine Phosphates of the Agulhas Bank," *S.A. Journ. of Industries*, Vol. IV., No. 10, November, 1921, pp. 863-865.
"Bacterial Production of Motor Fuel," *S.A. Journ. of Industries*, Vol. IV., No. 11, December, 1921, pp. 905-910.

B. de C. Marchand:
"On the Volumetric Determination of Phosphoric Oxide," *S.A. Journ. of Science*, Vol. XVII., Nos. 3 and 4, July, 1921, pp. 259-268.

W. J. Copenhagen:
"Studying our Marine Resources," *S.A. Journ. of Industries*, Vol. V., No. 4, April, 1922, pp. 160-163.

Extracts from the Reports of the Division's Officers in Charge at Capetown, Grootfontein, and Pretoria.

1.—*Capetown: Chief of the Division.*

(*a*) *Analytical Work.*—During the year 477 samples of various kinds were analysed. Of these, the analyses of salt, brine, bittern, etc., were performed for the purpose of a general survey of the salt-pans of the Union; and an investigation into the nicotine-content of various types and qualities of tobacco grown in the Union was undertaken in connection with the production of a satisfactory tobacco extract. An analysis of ash from tobacco stems yielded 17.8 per cent. of potash.

With the exception of seventeen samples of guano and a few analyses of limestone, practically all the fertilisers analysed were in connection with the Fertilisers, Farm Foods, and Pest Remedies Act.

As usual, several analyses of Government guano were made, and a series of

comparative analyses of the produce of the different islands are also in progress. Limestone from Saldanha Bay crushed for use as agricultural lime was found to contain 36.3 per cent. of carbon dioxide, corresponding to 82.5 per cent. of calcium carbonate. Some limestones and supposed phosphatic deposits from Dassen Island were examined, but the results were not promising.

A special report on the subject of the change in the composition of basic slag was furnished, also one on the alleged poisonous character of basic slag and other fertilisers.

An investigation was commenced, and is being continued, in regard to the relation between the degree of ripeness of grapes and their sugar-content to their suitability for export.

A restricted amount only of soil investigation could be carried out. A sandy soil from the Caledon District was examined and found to be, as such soils usually are, indifferently supplied with humus, low in moisture-retaining power, and poor in plant-food. Two samples of virgin sandy loams from Kliphcuvel were also deficient in organic matter, nitrogen, and water-retaining power as well as in organic plant-food. Some soils from a farm at De Doorns proved to be rather brak, containing about 0.25 per cent. of sodium salts. A similar proportion was found in one out of three soils obtained from a farm in the irrigable area of the Olifants River, Van Rhynsdorp. A very brak soil from Middelburg, Transvaal, was examined. It contained 0.56 per cent. of sodium salts. A deep virgin soil of good humus-content, rich in nitrogen, and with a satisfactory moisture-retaining power, was received from the Ceres District, but its supply of inorganic plant-food could only be described as moderate. Ten soils from the Cradock Division were examined in connection with the construction of an irrigation dam.

The occurrence of collar-rot in citrus trees in the Clanwilliam District led to an examination of the soil for brak salts and acidity. In neither respect was the salt in any way at fault. The use of liquid hydrocyanic acid for the destruction of pests on fruit trees led to an investigation of the character of the liquid commercially applied for the purpose and the mode of its manufacture.

The only sample of water that requires any special remark was one from Bellville, tested for salinity in connection with its proposed use in dairying. It contained 51.2 parts of dissolved salts per 100,000, consisting almost entirely of sodium chloride.

As to plant products, a sample of *Senecio* from Newlands was examined in connection with its use as a poultry food. Some guinea grass from Somerset East was also analysed with a view to being utilised as fodder. Several plants were examined for their essential oil content, and the constants of those oils determined. Experiments were carried out to ascertain whether prickly-pear sections contain any saponin or pectin substances which could cause it to act as a "spreader" in insecticide washes, but nothing definite could be elicited. It was also sought to ascertain whether prickly-pear mucilage could partially replace gelatine if added when a solution of the latter was just below setting consistency. In this respect, too, the results were of a negative nature.

In connection with experiments at Elsenburg on feeding pigs with the residue of maize from which alcohol had been prepared and distilled off, analyses of mealie meal before and after treatment were carried out.

(*b*) *Toxicological Work.* — Occasional cases of supposed poisoning of stock were submitted for examination.

Several samples of strychnine were received at various times, with the complaint that they had been found ineffective for wild animal poisoning. In every case the article was found perfectly pure, and the fault must lie in the compounding of the bait.

The deposition of crystals in drums of concentrated sodium arsenite solution was inquired into, and attention given to the numerous untoward results of the careless or malicious use of the arsenicals employed in orchard spraying and stock dipping.

(*c*) *Microbiological Work.*—In connection with the commercial manufacture of acetone and alcohol from such cultures as maize or sweet potatoes, a bacillus capable of effecting the conversion of maize was obtained by the kindness of the Rockefeller Institute, and cultures were prepared for a large-scale production of these articles, but the plant was not located in a suitable environment, and was subsequently broken up.

Pure cultures of certain soil organisms were procured from the Lister Institute.

and sub-cultures of these were prepared and distributed amongst agriculturists for experimental purposes. Further samples of soil from different parts of the Union were sent to Rothamsted for the study of soil protozoa. Experiments in soil inoculation were initiated on several farms in the south-western districts.

(*d*) *Dairy Industry Act.*—Under the provisions of this Act, all milk and cream testing appliances offered for sale within the Union have to be tested for accuracy of *graduation and dimensions, and marked in* a Government laboratory. This practice was continued, and 616 articles examined during the year. They comprised 447 Babcock cream bottles, 72 Babcock milk bottles, and 97 pipettes. Of these, 46.9 per cent. were rejected, viz., 50.1 per cent. of the cream-test bottles, 86.1 per cent. of the milk-test bottles, and 3.1 per cent. of the pipettes.

(*e*) *Consultation Work.*—On frequent occasions reports had to be furnished on miscellaneous abstract questions submitted for advice, such as the manuring of sandy grass lands, horns as a fertiliser, preservation of foodstuffs, etc.

2.—*Grootfontein*: *A. Stead, B.Sc., F.C.S.*

Most of the period was occupied by the officer in charge in serving as a member of the Drought Inquiry Commission or on leave of absence. Other work included the inspection of manurial experiments, of brak land at Uitenhage, of prickly-pear spraying tests, of brak in an orchard near Cradock, the compilation of a comprehensive report on brak for the Department of Mines and Industries (still in progress), investigation of the feeding of sheep on prickly-pear as the main portion of their diet, investigation of farmers' experience in the Graaff-Reinet District regarding the utilisation of *Agave americana* as a stock food, experimental feeding of prickly-pear to cows and oxen, and continuation of sheep-feeding experiments.

In connection with the report on brak, referred to above, the methods adopted for reclaiming brak land near Robertson were inspected, and led to a recommendation that the Division of Chemistry should engage in such operations as, for instance, at Klipdrift, where the well-known efforts of the late Mr. J. P. Marais had failed.

A considerable amount of work of an advisory and consulting nature was also done.

3.—*Pretoria*: *B. de C. Marchand, B.A., D.Sc.*

(*a*) *Analytical Work.*—The samples received for analysis or examination comprised:—Soils and sub-soils, 146; fertilisers, 115; dairy products, 20; tobacco, 16; water, 15; miscellaneous, 69; total, 381. Of the soil samples, 54 were taken by officers of the Division in connection with investigational work. The only other soil samples which call for any comment were five sent in by the Postal Department in connection with the rapid corrosion of stay rods and plates. This was ascribed to alkaline salts in the soil. Preventive measures were suggested.

(*b*) *Dairy Glassware.*—The total number of pieces tested was 932, consisting of Babcock cream bottles 583, Babcock milk bottles 277, pipettes 72. The percentage rejected as incorrect was four.

(*c*) *Investigations.*—In addition to the continuation of others, investigations were commenced on the physical properties of soils, the influence of various factors on the citric solubility of the phosphoric oxide in basic slag, and the determination of "available" potash in soils.

The trials of various methods for the determination of phosphoric oxide in fertilisers were completed, and the results for the sample of basic slag experimented on were published in the *Journal of the South African Chemical Institute*, Vol. V., No. 1, p. 16.

(*d*) *Pot Experiments.* — In connection with certain of the investigations in hand, pot experiments on a small scale were commenced.

NOTICES OF BOOKS.

Outlines of Theoretical Chemistry, by F. H. GETMAN, PH.D. Third edition, thoroughly revised and enlarged. Pp. VIII. + 625. New York: Wiley & Sons, Inc. London: Chapman & Hall, Ltd., Henrietta Street, Covent Garden. 1922. Price 18s. 6d. net.

Getman's *Outlines of Theoretical Chemistry* is one of the best of those designed to meet the requirements of students following courses of physical chemistry. It is also a very useful guide and help for those engaged in giving such courses.

A working (but elementary) knowledge of chemistry and physics is naturally assumed. The matter is well arranged, and the re-

sults of recent researches have been incorporated with the subject matter in a very satisfactory manner.

Each chapter is followed by a set of questions which should enable the student to grasp the subject thoroughly.

The author has evidently spared little effort in searching the literature for the important advances that have been made since the earlier editions appeared, and this issue should prove as useful as the previous ones.

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(1) *Second Year College Chemistry.*
(2) *Laboratory Manual to accompany Second Year College Chemistry*, by William H. Chapin. Pp. XI. + 311 and VII. + 112. New York: Wiley & Sons, Inc. London: Chapman & Hall, Ltd., Henrietta Street, Covent Garden, W.C. 1922. Price 15s. net and 7s. 6d.

The trend of chemical science at the present time is reflected by the contents of advanced textbooks, and is, especially in America, directed towards a study of the fundamental principles rather than with the object of adding to the already immense store of facts and methods.

The present volumes by Prof. Chapin indicate this in no uncertain manner, and they are largely devoted to an account of the Chemical Laws and their experimental basis.

The importance of suitable and reliable textbooks of this kind cannot be overemphasised, since the average student, in his first and early years, is confronted with a mass of descriptive matter and particular facts mixed up hazily in his mind with those theories and generalisations with which they are associated.

Another good feature of the theoretical volume is the adoption of the historical method of treatment. This has led the author to introduce references and brief footnotes dealing with the scientists whose achievements are being discussed in the text. One or two of these require emendation, however.

The same volume contains a prefatory, "Suggested Course of Study," in which the author indicates that the test covers a year's work (32 weeks), and the Laboratory Manual can be used to cover the same period. All the experiments described are stated to have been tested with several classes of students.

In the preface to the Laboratory Companion the author rightly insists on the importance of the careful and correct use of the laboratory note-books. It often happens that a student is able to derive more knowledge from an unsuccessful experiment than from successful ones carried out casually and written up in an unsatisfactory manner.

Together, these volumes will be found quite suitable for those students for whom they are intended. Those in charge of laboratory classes will find the appendices to the experimental volume of use in planning the work.

Organic Syntheses, an annual publication of satisfactory methods for the preparation of organic chemicals. James Bryant Conant, Editor-in-Chief. Vol. II., pp. VI. + 100. New York: Wiley & Sons, Inc. London: Chapman & Hall, Ltd., Henrietta Street, W.C. 1922. Price 7s. 6d. net.

The publication of this series, one volume of which is to appear each year, has been undertaken by certain chemists in order to make their detailed directions for the preparation of various organic chemicals available in a permanent form.

The high cost of chemicals, and also the difficulty of obtaining supplies of even ordinary organic reagents during the war caused many researchers to prepare their own.

As frequently happens in such cases, the methods described in compendia and these given in the literature were often found to be unsuitable or at least capable of modification and improvement with regard to yield, cost and facility of preparation.

The results published in this series of "pamphlets" give the experiences and final methods adopted by well-known research workers in certain American Universities, and those of the Eastman Kodak Co. and Parke Davis Co.

The authors do not claim that their methods are ideal, but all have been tested by other experienced organic chemists.

Notes are appended to the methods given, and the original references are quoted.

Undoubtedly the methods of preparation for the 25 bodies described will be found satisfactory, but it is surprising that the authors have retained a slight modification of Skraup's Quinoline synthesis, involving two steam distillations, although in their *Notes* they mention the simpler method of E. de Barry Barnett *(The Chemical News*, 1920, CXXI., 205). Their selection seems to rest upon the fact that the chemists who tested the two processes obtained better re-

sults with the older one—an experience contrary to that of the present writer.

These volumes (Vol. I. appeared early last year, see *The Chemical News*, 1922, CXXIV., 174) should be available in all reference libraries, and they should be consulted by chemists wishing to know of reliable and simple processes for the preparation of moderate quantities of these reagents.

J.G.F.D.

BOOKS RECEIVED.

Handbook on Petroleum, by CAPTAIN J. H. THOMSON and SIR BOVERTON REDWOOD. Pp. XIX. + 342. 1922. Messrs. Charles Griffin & Co., Ltd., Exeter Street, Strand, W.C.2. 12s. 6d. net.

Organic Syntheses, by JAMES BRYANT CONANT and Others. Pp. VI. + 100. Vol. II. 1922. Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, W.C.2. 7s. 6d. net.

Dyes, and their Application to Textile Fabrics, by A. J. HALL, B.Sc. (LOND.), F.I.C., F.C.S. Pp. 118. 1923. Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, W.C.2. 3s. net.

A Method for the Identification of Pure Organic Compounds, by SAMUEL PARSONS MULLIKEN, PH.D. Pp. VI. + 238. Vol. IV. 1923. Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, W.C.2. 30s. net.

RAPID ESTIMATION OF IRON AND ALUMINA.

By F. LUCCHESI.

The iron and alumina are precipitated together with ammonia in the presence of ammonium chloride. The precipitate is well washed and dissolved in a known volume of semi-normal sulphuric acid. A few drops of methyl orange solution is now added, and the uncombined acid titrated with semi-normal caustic soda. Then, by difference, one can arrive at the amount of acid used in combining with the iron and alumina. A little concentrated H_2SO_4 is added to the solution, and the iron reduced with H_2S and subsequently titrated with deci-normal $KMnO_4$. From the two titrations the amounts of iron and aluminium oxides can be calculated.—(*Gionale di chim. Ind. App.*, 1923, p. 14).

The February issue of the *Empire Exhibition News*, the organ of the British Empire Exhibition, draws attention to the fact, which statistics have proved, that after four notable exhibitions boom years have followed, although lean years had preceded these exhibitions.

New Patents.

THIS list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

1980—Lland, W.—Production of alkali salts of higher fatty acids. Jan. 22.

2076—Rusberg, F.—Manufacture of alkali thiosulphate. Jan. 23.

2339—Soc. of Chemical Industry in Basle.—Manufacture of dye-stuffs. Jan. 25.

Specifications Published this Week.

191417—Kulas, C., and Pauling, C.—Process for the manufacture of resinous products of condensation from phenol and formaldehyde.

171367—Melamid, Dr. M.—Process of producing hydrocarbons of relatively low boiling point from tar oils.

191582—Haddan, R. — Recovery of aluminium chloride.

191630—Federal Phosphorus Co.—Production of phosphoric acid.

176785—Simon, T.—Manufacture of magnesium carbonate from dolomite.

190995—Legeler, Dr. E.—Process for the manufacture of sulphur proto-chloride.

Abstract Published this Week.

Recovery of hydrocarbons and sulphur from Coal Gas.—Patent No. 190203.—Badische Anilin & Soda Fabrik; Ludwigshafen-on-Rhine, Germany.

Coal or coke-oven gas, previously freed from tar, cyanogen compounds, and part of the ammonia content, is passed at ordinary or slightly raised temperature through a number of towers containing active charcoal, such as is obtained by charring wood with zinc chloride. In the first towers, all the benzene hydrocarbons are absorbed; in the next towers, the hydrogen sulphide is removed in the state of free sulphur, after a sufficient amount of oxygen-containing gas with or without ammonia has been added; finally, if desired, the ethylene hydrocarbons are absorbed in the last towers. By employing an arrangement of interchangeable towers, the process may be conducted in a continuous manner. Organic sulphur compounds, if present, are retained in the first towers along with the benzene hydrocarbons; any hydrocyanic acid present becomes converted into ammonium thiocyanate, and is also deposited in the first towers. The ethylene may be freed from ammonia, before or after absorption, by washing with aqueous sulphuric acid or other acid. Instead of absorbing ethylene as such in the last towers, it may be converted into ethylene compounds by interaction with halogens, &c., in the presence of the active charcoal, and these compounds are then retained. The absorbed substances are removed at intervals, for instance, by extraction with a solvent or by expulsion with steam.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3281.

RUBBER VULCANISATION.

The importance of the new rubber "accelerators" just perfected by British chemists has been explained by Major Lefebure, who is responsible for the development department of the British Dyestuffs Corporation.

He stated, in an interview, that the use of rubber was greatly restricted until about eighty years ago, when Hancock, Goodyear, Parkes and other pioneers discovered that it acquired some very valuable properties when vulcanised, that is, when associated with sulphur. It was only then that rubber began to come into its own; yet, up to some ten years ago, if rubber was needed to combine with sulphur in this way, a temperature of 140 degrees Centigrade or more was required. For a thicker article like ebonite or vulcanite, this temperature had to be maintained for many hours.

About ten years ago, it was discovered that by adding from a quarter per cent. to one per cent. of certain synthetic organic chemicals to the rubber the time of vulcanisation was reduced from one-half to one-eightieth, according to the size of the article and the nature of the synthetic organic chemical used. The process was termed acceleration, and it is no exaggeration to say that the use of synthetic organic chemicals in this way has been a landmark in the development of the rubber industry. The consequences are, in the first place, a very appreciable reduction in the amount of steam required in vulcanisation, which means a marked lowering of cost. The use of small percentages of synthetic organic chemicals introduces an entirely new control factor into rubber manufacture.

In America, where the rubber industry is so highly developed, there are very few rubber articles which are not made by the use of these accelerators, but in England we have been slower. An important new feature has now come into the situation. These accelerators are all synthetic organic chemicals which are either actually intermediates in the dyestuffs industry, or can easily be made from such intermediates. We have perfected products with special suitability for different types of rubber. Up to within a year ago it was fairly true to say that the British rubber industry was largely dependent on chemicals from foreign sources for this purpose. There were certain exceptions. Rubber manufacturers were even using chemicals under trade names without knowing what the chemicals were or without being sure that they could rely on getting them, in say, a year's time if they wanted to repeat them for any particular department of their work. Now that the British chemical industry has taken on the production of them, it will be possible to supply the rubber industry with satisfactory products for all types of rubber production.

Certain important results follow. For example, the range for useful articles in rubber, although wide, has been seriously limited owing to the fact that rubber has had to be vulcanised at 140 degrees Centigrade and over a long period of time. Many materials which would probably compound quite satisfactorily with rubber under less drastic heat treatment have had to be ruled out because of that high temperature. The possibility is now in sight of using such products and a good range of colours, for rubber flooring, hot-water bottles, and so on, is also made possible.

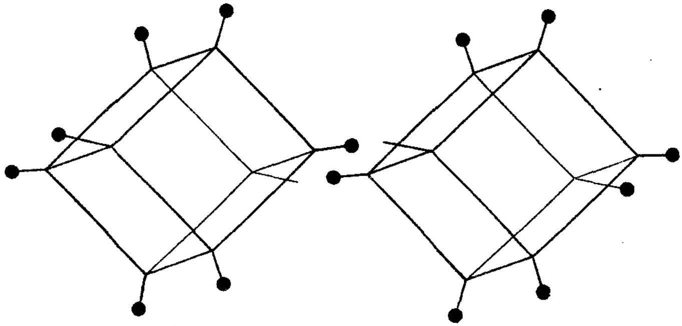
THE INFLUENCE OF THE ATOMIC NUCLEUS UPON VALENCE, ORIENTATION AND THE INDUCED POLARITY OF ATOMS.

By Herbert Henstock.

That the hypothesis of the Induced Polarity of Atoms is eminently practical, explaining, as it does, many hitherto obscure and often apparently unrelated phenomena, becomes more and more evident as its applications in various directions are brought to light. Up to the present, with one exception, there does not appear to be any attempt to explain, or attribute any underlying cause to this alternate polarity. The exception referred to is that of Kermack and Robinson (*Trans.*, 1922, CXXI., 427), who assign the cause to the number of electrons in the outer layers of the atoms and not to a precise definition of their supposed arrangement in space. This explanation is, however, only a partial truth and, as will be shown later, does not apply to alternate but to another kind of polarity.

The theory that induced polarity can alter the sign or the electrical effect of an atom, presupposes some easily alterable at-

tribute of that atom, an attribute which does not require any very great force to effect the alteration; for in a chain, say of carbon atoms, once the key atom has its polarity determined, the remainder easily alter their polarities in alternation with the first, each succeeding atom bringing about this effect in its neighbour. This cannot be due to the number of electrons in the octet, since this is a more or less constant quantity, and is altered only where large forces are brought into play, which may remove an electron from the octet of an atom as in an electro-valence, such forces being much greater than those required for an alteration in alternate polarity. The octets of the atoms in the fluorine[2] molecule may be represented as in Fig. I. The two atoms



A B

FIG. I.

may share two electrons as a co-valence, but there is no reason why one should be more positive than the other, if the mere numbers of electrons in the outer layers is considered. On the other hand, the author is in agreement with Kermack and Robinson in the view that alternate polarity is not altogether due to the supposed arrangement of the electrons in space. By this process of elimination there remains the nucleus, which, according to Lewis and Langmuir, may be viewed as a di-polar sphere having both poles positive and attended by the inner layer or layers of electrons, most of which are situated at or near the poles. If the nucleus, therefore, with its attendant layers of electrons and their position with respect to the octet be taken into account, a reason for the opposite polarities may be found. It is possible for the nucleus to rotate within the atom or for the octet to rotate around the nucleus, but when an atom exists in a compound its octet is more or less fixed, so that if there were any rotation it must necessarily be that of the nucleus, which would presumably carry the inner electrons with it. If this rotation[3] be stopped after passing through each angle of 90° there would be two opposing positions for the nuclear poles with respect to the outer layer of electrons: the fluorine atom, discussed above, might be positive or negative according as to whether the nuclear poles and their accompanying electrons pointed in a perpendicular direction, A, or in a horizon-

[2] *This element was chosen because its internal construction of nucleus and two electrons is fairly simple, and its octet has only one vacant corner, permitting of but a single normal primary valence bond.*

[3] *The atom may be normally in a static condition as assumed by Langmuir, but the dynamic condition considered by Bohr may be caused by outside influences, which rotate the nucleus.*

tal direction, B (see Fig. II.) with respect to the face a.b.c.d. containing the line a b which forms the edge where a co-valence bond exists. Naming the two nuclear poles, in both A and B, x and y, then if in A the distances between ay and by be called unity, those between ax and bx will be in the ratio

$$\frac{ax}{ay} = \sqrt{\frac{R^2+\left(\frac{R}{\sqrt{2}}+r\right)^2}{R^2+\left(\frac{R}{\sqrt{2}}-r\right)^2}}$$

to the former; where R = radius of sphere occupying the atomic volume and r = radius of sphere occupying the nuclear volume. On the contrary, in atom B the ratio will be ax : by : : 1 : 1. Thus the pole y, in A, is at unity distance from b, but the pole x is at a distance greater than unity from (a), whereas in B both these distances are unity. But since the nucleus is by no means saturated or counter-balanced by the inner electrons, the valence bond (a b) in A will have a less quantity of positive electricity opposed to it than will (ab) in B. and will in consequence attach itself to B, or to any atom constituted like B, the edges (a b) in each making the union. The direction of the nuclear poles in B is such that it will tend to attract electrons to the edge (a b) and to fill up the octet, thus making a stable arrangement which will constitute B a negative atom, and necessarily A will be a positive one.

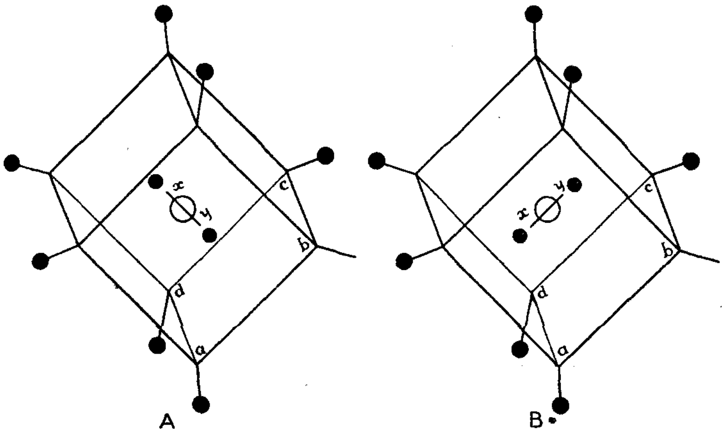
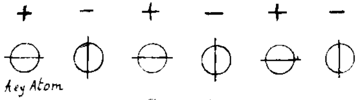


FIG. II.

The rigidity of this scheme and of its further applications here set forth, is not insisted upon; it has been used more as a graphic medium for conveying the author's meaning than as an exact picture of what takes place.

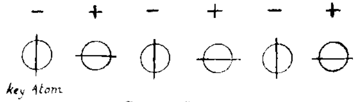
It can be stated, therefore, that a strong outside influence may rotate the nucleus of an atom in a chain and so determine its polarity and the atoms directly attached to it will have opposite polarities induced by the rotation of their nuclei, caused by the nucleus of the first atom, which may be looked upon as forces acting at a distance, as assumed by Lapworth (*Mem. Manchester Phil. Soc.*, 1920, LXIV., 1-17; *Trans.*, 1922, CXXI., 416).

Such an alternate polar effect might be shown by considering the nuclei of the atoms without their electrons, somewhat as follows:—



SYSTEM I.

If the polarity of the key atom were altered we should then have the opposite effect, viz.:—



SYSTEM II.

where the poles of the nuclei have been rotated through an angle of 90°.

Particular attention should be given to the fact that there is a fundamental difference between the older conceptions of polarity, as applied to an electro positive or electro negative element in the electro chemical sense, or as applied to ions, and the newer conception of induced polarity. The term polarity, as at present in use, includes two kinds: (1) what might be termed "Permanent-Periodic Polarity," or simply permanent polarity, or that which is due to the greater or less numbers of electrons in the octet, combined with the greater or less strength of the nucleus: this is a permanent periodic function of the elements, running from the single electron and seven vacant spaces in the octets of the strongly electro positive alkali metals to the seven electrons and one vacant space of those of the strongly electro negative halogens, in the usual periods of the periodic table. The formation of ions also may be put down in the same category, for although the ion contains one more or less electron than the atom, nevertheless the formation is confined to the octet, this type of polarity being merely enhanced on passage from atom to ion. The foregoing description is that of the older ideas of polarity. (2) What Lapworth has called "Latent Induced Alternate Polarity," or that which is due to the position of the nucleus with respect to the outer layer of electrons, as has been demonstrated above; this is a variable and transitory condition of an atom depending upon its environment, and it is the immediate cause of the determination of orientation. The strength of this kind of polarity will, however, be much less than that exerted by the outer electrons, which will determine the electro positive or negative nature of one element to another and not as in this case the polarity of the atoms of the molecule of an element to one another or the alternate polarities of the atoms of a chain. Induced polarity is not a periodic function of the elements; it is overbalanced in the more strongly positive or negative elements in the permanent-periodic sense; such elements as the alkali metals or the halogens scarcely show alternate polarity, which becomes apparent only in the more neutral elements, such as carbon. Lapworth's use of the word "latent," in this connection, is very apposite since either positive or negative alternate polarity may be called into being in an atom, the possibility being inherent in its constitution.

The two types of polarity may perhaps be more clearly seen if considered with respect to a single element. Chlorine is extremely electro negative in permanent periodic polarity, but in its molecule one atom may be weakly positive, the other negative consistently with induced polarity; positive chlorine may therefore exist in a compound. If this assumption of the rotation of the nucleus be extended to the other elements the same simple relationship will be found. Hydrogen has no inner electrons, and is always positive in "permanent periodic polarity": the union of two of its atoms to form a molecule being brought about by the rotation of the nucleus alone, one atom being positive in both kinds of polarity will rotate the nucleus of the second atom, making it negative in alternate polarity, but still remaining positive in permanent polarity. We can therefore have negative hydrogen without any very great bouleversement of our older ideas concerning this element. The inert gases, having no primary valence bonds, cannot exhibit any kind of polarity; they might conceivably display weak alternate polarity, if, as some chemists opine, they can form compounds by means of partial valencies.

Should such compounds be proved to exist, then the inert gases would be capable of exhibiting polar properties which could not be accounted for by means of the older idea of polarity. The remainder of the elements in the series, sodium to fluorine, each having two inner electrons, will act in a fashion similar to that already described

for fluorine, but since they have less numbers of electrons *in their octets they will* have a larger number of co-valence bonds, each of which will be positive or negative according to the quantity of positive electricity, which the rotation of the nucleus opposes to it in any given condition of the molecule in which atoms of these elements may exist. *Carbon, having four electrons* symmetrically situated in its octet, will more easily change its induced polarity than will those elements on either side of it; for in any atom the nucleus will tend to set itself as symmetrically as possible with respect to the electrons in the octet, and will continually tend to return to such a position when not influenced by outside forces which restrain it; the symmetry of the uncombined carbon octet permits the nucleus to remain in almost any position without strain. Elements of higher atomic weight *than those of this series will not change* their induced polarity so easily as the latter, since they have a larger number of electrons in their inner layers which will act as a retarding influence.

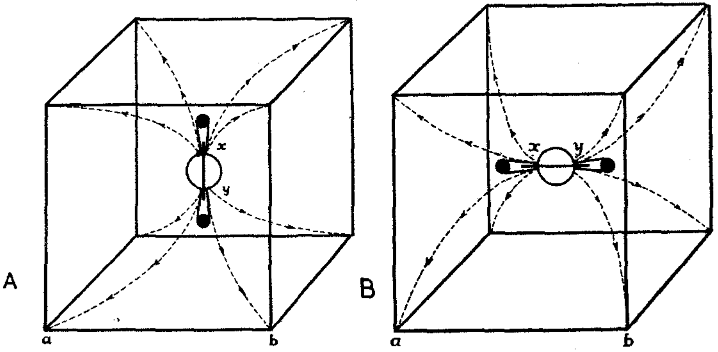


FIG. III.

Before leaving the subject of alternate polarity it may be well to note that the whole idea of the rotation of the nucleus is bound up with that of action at a distance. *Actuated by repulsive fields or Faraday* tubes of force emanating from the nucleus of a key atom, the nuclei of adjoining atoms are repelled and alter their positions by revolution round their own centres, thus altering the direction of their positive tubes of force (Fig. III.) which is the immediate cause of the *alteration in polarity of* such atoms. This change in the directions of the tubes of force reacts upon the electrons and vacant corners of the octet with a consequent fluctuation in the powers of attraction at its various parts, which may vary the orientation in the molecule of which the atom is a part, *or may even influence the* valence of the atom concerned. For tubes of force, see Lapworth (*Trans.*, *loc. cit.*)

THE EFFECT OF THE NUCLEUS UPON VALENCE.

If this suggestion be applied to valence, it will be seen that it corroborates, in a remarkable manner, Lewis' and Langmuir's representations.

(1) Electro valence is determined chiefly by permanent polarity. Where a permanently polar, electro negative element, as for example chlorine, which has its octet nearly complete, and tending to final completion by the actual passage of an electron from another atom of a permanently polar electro positive element, say sodium, unites with the latter with formation of an electro valence bond between the two, the negative permanent polarity is so strengthened by the alternate polarity, both acting in the same way, that the united force exerted is sufficient to tear an electron from the octet of the positive sodium, in which both kinds of positive polarity are operating in the same direction (but in an opposite one to that in the negative chlorine), tending to

give up an electron. The action might be compared with the united pull exerted upon the earth by the sun and moon when both are on the same side of the earth. The *actual passage of an electron from octet to octet is effected only by the considerable force here exerted, and occurs chiefly between elements strong in permanent polarity, i.e.,* those near either end of each series or period of the periodic table.

(2) Co-valence is determined by a similar group of forces, but the permanent polarity and alternate polarity combined are not *sufficiently powerful to remove an electron from one atom to another*, hence a sharing of electrons. The elements, which exhibit co-valence in a supreme degree and rarely display electro valence, are those in which the permanent polarity is weak, and are represented by the ones towards the middle *of each period of the periodic table. From* the foregoing it is therefore apparent that the only difference between electro valence and co-valence is one of degree, which view is practically identical with that expressed by Briggs (*Trans.*, 1921, CXIX., 1876), and also by Kermack and Robinson (*loc. cit.*)

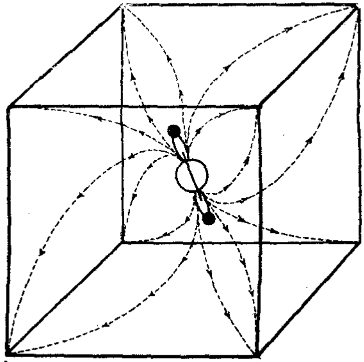


FIG. IV.

The partial valencies discussed by Lapworth and by Kermack and Robinson might be explained on the assumption that the nucleus may be partially rotated through an angle of 90°, *i.e., through a fraction of* that angle, in some such way as that contemplated in Fig. IV., where the tubes of force emanating from the nuclear poles will reach the corners of the octet in a different set of directions from, and with forces varying from, those depicted in Fig. III. for primary valence: thus some of the octet corners might be opposed to both nuclear poles, others to but a single one, which would strengthen or weaken their power of attracting electrons, and where such strengthening occurred partial valencies might be possible; each of the corners might or might not be occupied by an electron, and thus a considerable number and *variety of possibilities for partial valencies* would occur. When a corner of the octet of an atom is unoccupied by an electron and the nucleus is partially rotated so that the tubes of force from both nuclear poles can bear upon this point, a negative partial valence will result, but where the corner is *occupied a positive one will occur.* This is in agreement with the statement of Briggs (*Trans.*, 1919, CXV., 278) concerning positive and negative affinity.

The Effect of the Nucleus upon Orientation.

The idea of the rotation or oscillation of the nucleus is not inconsistent with (on a *larger scale*) the known phenomena of astronomy, and it is more than probable, as has been already assumed by others, that the electrons of the octet, as well as those of the inner layers, oscillate about fixed positions in the atom. Such rotation or oscillation of the nucleus is chiefly dependent upon the strength of forces acting from without the atom, any alteration in these forces would tend to rotate the nucleus wholly so as to alter the polarity of the atom to opposite sign, or partially so as to weaken the existing polar sign. In the case of one atom of a chain of carbon atoms, this would firstly alter the power and direction of the tubes of force operating upon the bonds with side atoms or chains, and might rearrange such bonds, their direction and the consequent orientation on that particular atom also depending to some extent upon the atoms or groups already attached to it; secondly, it would react upon the nuclei of the succeeding atoms with possibly similar results, and so orientation in the molecule would be directly dependent upon the amount of rotation of the various nuclei, the whole resulting from the action of the nucleus of the key atom or atoms, together with the secondary influence of the side chain atoms or groups. For descriptions of the action

of these latter, see papers by Lapworth, Kermack and Robinson, Flurscheim, etc. *It should be noted, therefore, that the* nucleus does not necessarily remain rigidly in the positions indicated in Fig. II., but may oscillate about these positions, so that when a strong key atom influences a chain of atoms, this oscillation may be thereby considerably retarded, or even stopped, when the nuclear poles would face the various edges or corners of the octets, where valence unions are possible, in a more permanent fashion, and so strengthen those positions that such unions would be encouraged. This permanency of position would render the various atomic bonds more positive or negative, and thus more or less reactive, as the case might be, depending upon the polarity of any other reacting atom or group.

The polarity of a group depends to a considerable extent upon the position of the nucleus of that atom, which will affect the union with another group, and since this position is referable to the strength of the key atom or atoms, this is one of the chief agents, which regulates the affinity of groups and in the end their orientation in the molecules they may enter. As an example, the amido and acetyl groups given by Lapworth, will illustrate this. In the amido group the nitrogen is negative in alternate polarity, and similarly in the acetyl group the carbon atom attached to oxygen is positive, consequently the two unite to form acetamide. Again in the NO_2 group the nitrogen is positive, hence NO_2 does not unite with CH_3CO. Here, then, we have nitrogen in two groups, negative in one and positive in the other, a phenomenon which is not readily explainable under the older idea of permanent polarity, nor even by a rearrangement of the electrons of the octets of the atoms concerned, but of which a simple solution is afforded by the idea of the rotation of the nucleus underlying alternate polarity as described in the preceding pages. The effect of these two nitrogen-containing groups upon orientation in aniline and nitro-benzene has been shown by Vorländer (*Ber.*, 1919, LII., 263).

The explanations of orientation given by Gough and Thorpe (*Trans.*, 1919, CXV., 1155), and also those by Lapworth and Shoesmith (*Trans.*, 1922, CXXI., 1391) are interesting as demonstrating the case with which the polarity of the atoms is altered, not merely along a simple chain of carbon atoms, but even through a part of the benzene ring, which goes to show that some easily alterable function of the atoms is brought into operation, such as might be attributed to nuclear rotation, where little force is needed to affect its alteration.

The author wishes to express his gratitude to Prof. A. Lapworth, for his kindness in criticising this communication, and also for much valuable advice in connection with it.

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[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY, CORNELL UNIVERSITY.]

GERMANIUM. IV.—GERMANIUM TETRA-IODIDE.[1]

BY L. M. DENNIS AND F. E. HANCE.

(From the "Journal of the American Chemical Society," December, 1922.)

(Continued from Page 118.)

From these experiments it would appear that the result of the vapour-density determination at 440° made by Nilson and Pettersson showed agreement with the theoretical vapour density not because germanium tetra-iodide does not dissociate at that temperature, but rather because the vapour consists of a mixture of undissociated tetra-iodide and of vapour of iodine which results from the dissociation of the tetra-iodide and which at 440° is diatomic.[8] $GeI_4 \rightleftharpoons GeI_2 + I_2$.

Before leaving the point, however, two determinations were made of the vapour density of germanium tetra-iodide with a modified Victor Meyer apparatus.[9] The tube was heated in an electric resistance furnace which made possible the regulation of the temperature within narrow limits, 442-446°. Taking the temperature as 445°, 0.2827 and 0.6209 g. of substance gave 10.5 and 24.5 cc. of displaced gas at 0° and 760 mm., equivalent to vapour density of 20.87 and 19.67 respectively.

These results show the same agreement with the calculated vapour density, 20.01

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[1] *The investigation upon which this article is based was supported by a grant from the Heckscher Foundation for the Advancement of Research, established by August Heckscher at Cornell University.*

[8] *Meyer, Ber.*, 1880, XIII., 394, 401.

[9] *Weiser, J. Phys. Chem.*, 1916, XX., 532.

as was obtained by Nilson and Pettersson, but crystals of free iodine were found in the inner tube at the close of each determination which proves that germanium tetra-iodide undergoes partial dissociation under these experimental conditions.

Chemical Properties.—Winkler[2] stated that germanium tetra-iodide is highly hygroscopic and that it deliquesces when exposed to the air. He found that it first gained in weight (50 per cent. in 1 day), and then lost weight during the next 18 days, the residue then weighing only about ¼ as much as the original sample.

Several different samples of the substance that we have prepared have shown identical properties which are widely different from those that Winkler has described. Germanium tetra-iodide neither gained nor lost appreciably in weight when exposed to the air for 2 days. A sample that weighed 0.5622 g. was allowed to lie on a watch glass exposed to the air of the laboratory for 5 months. At the end of that period its weight had decreased 6.5 mg., and a slight, white incrustation had formed around the sample on the watch glass, but the appearance of the sample was unchanged.

When germanium tetra-iodide is immersed in a small amount of water, it is slowly decomposed with the separation of geranium dioxide, which dissolves when more water is added and forms a clear, colourless solution of acid reaction.

A sample of the compound, placed under conc. sulphuric acid of room temperature, apparently suffered no change in 24 hours, for at the end of that period the acid gave no test for either germanium, or iodine, or for hydriodic acid. When the acid was warmed to 80°, iodine was slowly liberated.

When placed in a 1:4 solution of potassium hydroxide, germanium tetra-iodide is slowly dissolved. Under conc. nitric acid it turns black and nitrogen dioxide is evolved. After standing under the acid for 4 months, the residue still retained its black colour.

Conc. hydrochloric acid of room temperature slowly dissolves germanium tetra-iodide, solution being complete after some weeks. When dropped into conc. ammonium hydroxide, the compound is at once decomposed and decolorised, a white solid being formed. When exposed to dry ammonia gas, the substance is slowly converted into a white powder that is soluble in water.

Solubility.—Germanium tetra-iodide dissolves without apparent decomposition in the liquids listed below, the solution in each case undergoing no visible change for 4 months.

Solvent.	Colour of solution.
Benzene	Red-orange
Carbon disulphide	Red-orange
Methyl alcohol	Deep orange
Ethylene chloride	Light orange
Monochlorobenzene	Red-orange
Carbon tetrachloride	Light orange
Ethylene glycol	Very light yellow
Ethylene chlorohydrin	Very light yellow

The following solvents dissolved the substance at once, but decomposition slowly took place.

Solvent.	Colour of solution.	After standing for 4 months.
Hexane	Orange-red	Pink (free iodine)
Amyl alcohol	Deep orange	Yellow ppt., brown solution
Chloroform	Pale yellow	Reddish yellow solution
Nitrobenzene	Red-orange	White ppt., dark brown solution
Petroleum ether	Pink	Decomposition, black ppt.
Butanol	Orange	Dark brown solution
Glacial acetic acid	Pale yellow	Dark brown solution

The following liquids decomposed the substance at once.

Acetone	Light brown ppt.
Ether	Ruby-red solution, yellow ppt.
Turpentine	2 liquid layers formed, the upper one a light red, the lower a deep orange; solidresidue, dark brown in colour
Oil of lavender	Light yellow ppt. changing to black
Absolute alcohol	Yellow solution, white ppt.
Iso-propyl alcohol	Orange solution, white ppt.
Pyridine	Light yellow solution white ppt.
Amyl alcohol	Brown solution, white ppt.

SUMMARY.

This article deals with the preparation of germanium tetra-iodide, its analysis, the

determination of its melting point, crystal form and specific gravity, its colour at various temperatures, the sublimation and dissociation of the compound, and some of its chemical properties.

Ithaca, New York.

ARABIAN ALCHEMY AND CHEMISTRY.

On Tuesday, February 13, an important lecture on the above-mentioned subject was delivered, under the auspices of the Royal Asiatic Society, by Mr. E. J. Holmyard, the Rt. Hon. Lord Chalmers, G.C.B., presiding.

After expressing his appreciation of the greater interest now shown in the history of science, and emphasising the importance of its study, Mr. Holmyard pointed out that there was a serious gap in our knowledge of the history of alchemy and chemistry. During the period 600-1000 A.D. chemistry was monopolised by Islam. The alchemical MSS. of this period had received but scant attention owing to the difficulties of Arabic. Berthelot had had about thirteen of them translated, but at least three hundred were known and, no doubt, many more existed.

Dealing with the Arabian alchemists individually, on the basis of a first-hand study of the original MSS., Mr. Holmyard dismissed Khalid as incomprehensible. Geber, however, was a man of a very different type, and Mr. Holmyard controverted the views of Berthelot regarding the Latin works ascribed to Geber, and gave reasons for regarding these as genuine translations of works by the Arabian alchemist. Berthelot was acquainted with only a very few of Geber's works, and Mr. Holmyard suggested that these were not, strictly speaking, his chemical works, but mystical writings in which—as a chemist—Geber had employed chemical symbolism to express his religious ideas. The originals of the Latin works ascribed to Geber had not been discovered, but there was an Arabic MS in the British Museum by Geber, entitled the "Book of Properties," which resembled these books in character. The sulphur-mercury theory of the metals was clearly stated in Geber's Arabic works, and the "Book of Properties" contained many practical recipes, such as recipes for the preparation of basic lead carbonate, metallic lead, mercuric sulphide, etc.

The later Arabian alchemists, such as Rhazes, were also briefly dealt with by Mr. Holmyard, who pointed out that, in general, they were men of a practical turn of mind, and illustrations from an Arabic MS in the British Museum, showing the various forms of apparatus used by them, were shown by means of the lantern.

In the discussion which followed, amongst other speakers, Prof. Browne, Dr. and Mrs. Singer, Mr. R. Steele, and Mr. H. S. Redgrove took part. Mr. Redgrove referred to the work that the Alchemical Society, which existed prior to the war, had done to stimulate interest in the history of chemistry. He warmly congratulated Mr. Holmyard on his achievement in substantiating the genuineness of the Latin works of Geber, and raised the question as to the origin of the sulphur-mercury theory, an important factor, in his opinion, being the tendency of the old-time thinkers to base their theories on analogies, not infrequently of an unwarranted character.

NEW BRITISH CHEMICAL STANDARD.

Basic Slag "A."

The British Chemical Standards Movement announces the issue of a Basic Slag Standard.

The special uses of this are twofold:—Primarily as an analytical standard for total phosphoric acid and phosphates; and as a standard mainly for basic steel makers, but also for acid steel makers, iron and steel founders and others, to enable them to check their methods for silica, iron, lime and magnesia, etc., in slag.

The analysis is as follows:—Phosphoric Anhydride (P_2O_5), 12.93 per cent., equal to Phosphates ($Ca_3P_2O_8$) 28.24 per cent., iron 8.97 per cent., silica 16.15 per cent.

During the standardisation of this slag the need for such a standard has been made abundantly evident to the organisers, for it has been found that even in the determination of such elements as iron, silica, lime and magnesia, which, it may be thought, present little or no difficulty, improvements in methods have been essential in order to get agreement between experienced chemists.

The standard has been tested by a selection of 16 prominent chemists representing

Independent analysts, both metallurgical and agricultural;
The U.S. Bureau of Standards,
English and French Iron and Steel Works' Chemists (manufacturers), and
English Basic Slag Grinders and Merchants.

It is hoped that chemists will take full advantage of this standard, which has been prepared with the object of promoting unification of analysis.

GENERAL NOTES.

BRITISH INDUSTRIES FAIR.

The vast mass of exhibits to be displayed at the 1923 British Industries Fair at London and Birmingham, between February 19 and March 2, possesses two angles of interest to both home and overseas buyers. The first is covered by the numerous commodities which have only in recent years been produced in Great Britain; the second will be found in the still larger number of exhibits of goods which, while always noted for British quality, will show notable improvements at the Fair, where novelty will be found allied with quality.

In giving the overseas buyer the opportunity to inspect specimens of products and commodities which have only been established in Great Britain during comparatively recent years, the Fair fulfils the first essential of its existence. One of the most interesting sections falling under this class will be that devoted to dyes and fine chemicals. The exhibits in this representative and comprehensive section will range from the rarest of fine chemicals for medicinal and research purposes to those known as "heavies" and sold by the truck load.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

Board of Trade Announcement.

The total number of applications received during January was 562, of which 473 were from merchants and agents. These were dealt with as follows: Granted, 359; refused, applicants being referred to British makers (British equivalents being available), 94; referred to Reparation supplies, 53; outstanding on January 31, 56.

MOROCCO.—PHOSPHATE BEDS.

Mr. C. E. Heathcote-Smith, O.B.E., H.M. Consul at Casablanca, has forwarded *to the Department of Overseas Trade* the following interesting report on phosphates in Morocco:—

Extent of Moroccan Phosphates.—By the discovery of rich and vast phosphate beds, Morocco has become a potential factor of economic importance.

It is credited with the possession of deposits rivalling in extent those of Florida, and in content those of any other country in the Eastern Hemisphere.

Thus the *Oued Zem-El Bouroudj* beds (160 km. south of Casablanca) cover a district of some 75 km. in length and from 5 to 35 km. in breadth. They consist of horizontal layers several metres deep, lying *practically on the surface, covering an area* of some 400,000 acres, and composed f a fine sand which is nothing other than phosphate of lime of so high a percentage (73 to 78 per cent.) that Florida alone can show similarly rich deposits. Even the bed other than at El Bouroudj also contain a high percentage of phosphates varying from 68 per cent. to 72 per cent. As for their quantity, estimates vary from "many millions of tons" to "hundreds of millions."

It has been calculated that even if the beds were exploited at the rate of several millions of tons annually, centuries will elapse before their exhaustion.

The American rubber-growing proposals are dealt with by a London correspondent of the *Manchester Guardian Commercial* in the last issue. "Quite a number of Americans interested in the rubber trade have been in London lately," he says, "and they are all prophesying a considerable shortage in the visible supplies of rubber before the end of the year. At the same time they are visibly upset at the present price of the commodity, and profess to anticipate higher prices still. It appears to have been suddenly realised that the American is practically dependent upon Britishers for the whole of her rubber needs ,and it is being suggested both here and New York that rubber estates on the British plan shall be established in the Philippine Islands by American interests to supply America's needs in the far future. Experts in rubber here ridicule this suggestion. It is pointed out that the Philippines are parcelled out in small tracts for the benefit of the nation,

and that legislation would be needed to alter this system. Again, an American buyer has assured me that the climate is entirely unsuitable, and that the only favourable factor is that Chinese labour for tapping is easily procurable. The same buyer (who is well known in Singapore) admitted that but for British enterprise American rubber users might be paying ten times the price of rubber per pound that they have to do now; he ridiculed the whole idea of Philippine rubber, and hinted that some of his countrymen would do better to pay the market price quietly, as do the cotton buyers in Manchester and Liverpool, instead of getting publicity for themselves over here and incidentally contributing to the tendency for rubber quotations to go still more against their own market."

CHEMICAL TRADE WELFARE.

In the House of Commons recently, Mr. Wignall asked the Home Secretary if a welfare order had been issued to the chemical trade, as promised in March, 1922; and, if not, would he say when such an order would be issued to this industry?

Mr. Bridgeman replied that the draft regulations which were referred to in the answer to the question asked by the honourable member on March 27, 1922, were finally made and presented to Parliament in July last, and the great majority of them took effect on October 1. In the case of a few of the regulations, however, strong objection was taken to their immediate enforcement on the ground of the structural alterations involved, and it was agreed, and was provided in the regulations, that the requirements in question should not come into force till April 1 next, or such later date or dates as the Home Secretary might appoint.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, FEBRUARY 22, 1923, AT 4.30 P.M.

The Bakerian Lecture was delivered by G. I. TAYLOR, F.R.S., and C. F. ELAM, on *The Distortion of an Aluminium Crystal during a Tensile Test.*

The object of the test described was to determine the nature of the distortion which occurs when a crystal of aluminium is extended by a direct pull, and to find out the relations between the orientation of the crystal axes and the direction of pull.

A rectangular specimen 1 × 1 × 20 cm. was cut from a round bar of aluminium which had been treated by the method of Carpenter and Elam, so that it consisted of one single crystal. This was stretched through successive extensions of 0, 10, 20, 30, 40, 60 and 78 per cent. of the original length, and at each stage of the test the distortion was determined by measurements of scratches ruled on the surface. At the same time the directions of the crystal axes were determined in each case by X-ray analysis.

The method developed for determining the nature of the distortion, by which any configuration of the specimen was strained into any other, was to find lines of particles which were unextended by the strain. The directions of these lines lie on a quadric cone, which evidently has two positions corresponding with the two configurations from which it was derived.

On applying this method to the specimen under consideration, it was found that for all stages of the extension up to 40 per cent. elongation the "unextended cone" was of a degenerate form consisting of two planes, one of which contained in all cases the same particles, while the other contained different particles for different strains. The former plane was evidently undistorted during the whole strain up to 40 per cent. elongation, and the distortion was due to slipping or shearing over this plane.

The orientation of the crystal axes was determined by X-ray measurements, and it was found that the slip plane was identical with an octahedral (111) plane of the crystal. The direction of the shear was also determined and found to be along one of the three principal lines of atoms in the octahedral plane.

When the specimen was extended beyond 40 per cent. elongation, it was found that the distortion was no longer due to slipping on one plane. This was explained by showing that the effect of the shear was to rotate the axis of the specimen relative to the crystal axes in such a way that another (111) plane came into a position where its inclination to the axis was the same as that of the slip plane. Under these circumstances slipping might occur on both planes simultaneously, and it was verified that this was the case.

THURSDAY, MARCH 1, 1923, AT 4.30 P.M.

Papers read:—

A. MALLOCK, F.R.S. *The Effect of Temperature on some of the Properties of Steel.*

PROF. C. H. LEES, F.R.S. *Inductively Coupled Low Resistance Circuits.*

LORD RAYLEIGH, F.R.S. *Studies of Iridescent Colour, and the Structure producing it. I.—The Colours of Potassium Chlorate Crystals.*

LORD RAYLEIGH, F.R.S. *Studies of Iridescent Colour, and the Structure producing it. II.—Mother of Pearl.*

LORD RAYLEIGH, F.R.S. *Studies of Iridescent Colour, and the Structure producing it. III.—The Colours of Labrador Felspar.*

Paper read in title only:—

L. V. KING, D.Sc. *On the Complex Anisotropic Molecule in Relation to the Dispersion and Scattering of Light.* Communicated by Prof. A. S. Eve, F.R.S.

ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on March 2, at 9 o'clock, will be delivered by GEORGE C. SIMPSON, C.B.E., D.Sc., F.R.S., Director, Meteorological Office. The subject is *The Water in the Atmosphere.*

On Saturday, March 3, SIR ERNEST RUTHERFORD, LL.D., D.Sc., F.R.S., M.R.I., Prof. of Natural Philosophy, will deliver his third lecture on *Atomic Projectiles and their Properties.*

ROYAL SOCIETY OF ARTS.

On Monday, February 19, DR. H. P. STEVENS, F.I.C., delivered his third Cantor lecture on *The Vulcanisation of Rubber.*

At the Ordinary Meeting on Wednesday, February 21, C. A. MITCHELL, M.A., F.I.C., gave a paper on *Handwriting and its Value as Evidence.*

On Wednesday, February 28, 1923, PROF. W. E. S. TURNER, O.B.E., D.Sc., F.INST.P., Head of the Department of Glass Technology, University of Sheffield, delivered his lecture, entitled *Heat Resisting Glasses.* The Hon. Sir Charles Algernon Parsons, K.C.B., LL.D. D.Sc., F.R.S., presided.

THE FARADAY SOCIETY.

At the meeting held on Monday, February 19, the following papers were communicated:—

Electrolysis with an Aluminium Anode the Anolyte being: I. Solutions of Sodium Nitrite; II. Solutions of Potassium Oxalate. By F. H. JEFFERY, M.A.

Summary:

With solutions of *sodium nitrite* probably the primary product of reaction at the anode is aluminium nitrite, which is hydrolysed rapidly to hydrated aluminium oxide and nitrous acid, this latter giving rise to nitric oxide and nitric acid.

There is no evidence of the formation of a complex anion of aluminium from these experiments.

With solutions of *potassium oxalate* the product of reaction at the anode is a complex anion derived from aluminium.

The salt $K_3[Al(C_2O_4)_3] \cdot 3H_2O$ can be derived from the anolytes after electrolysis.

From this mode of derivation it seems very probable that the sale is a true complex salt comparable with potassium chromioxalate.

If this be true, the alumini-oxalate complex can be represented in three dimensions just as Werner represented the chromioxalate. Jaeger resolved the racemic potassium chromioxalate by means of the potassium distrychnine salts. It may be that conditions can be found for the resolution of the alumini-oxalate.

The isolation of a complex salt from an anolyte does not imply necessarily that the constitution of the anionic part of this salt is identical with that of the complex anion present in the anolyte after electrolysis.

An attempt was made to examine the complex anion in solution by the electrometric method developed for the investigation of the plumbo-nitrite complex $[Pb(NO_2)_4]$ which was described in a previous paper to the Society. Solutions of potassium oxalate containing a known concentration of the potassium alumini-oxalate were prepared, but an aluminium electrode immersed in such a one had a potential so variable as to be useless for trustworthy determinations; nor were any conditions found to nullify this disability.

The Law of Distribution of Particles in Colloidal Suspensions, with Special Reference to Perrin's Investigations. Part II., by ALFRED W. PORTER, D.Sc., F.R.S., F.INST.P., and J. J. HEDGES, B.Sc.

On a Relation between Surface Tension and Density, by D. B. MACLEOD, M.A., D.Sc.

On a Relation between the Viscosity of a D. B. MACLEOD, M.A., D.Sc.

On the Viscosity of Liquid Mixtures showing Maxima, by D. B. MACLEOD, M.A., D.Sc.

General Conclusions.

1. The viscosity of liquid mixtures is a

function of the free space of the constituents and of the mixture.

2. In the case of liquid mixtures showing a maximum, the increase of viscosity is due, mainly, to the increase of density, which in turn is due to the chemical affinity between the constituents.

3. It is probable that, complexes which are formed, further reduce the free space and consequently increase the viscosity.

Electric Potential of Antimony-Lead Alloys, by S. D. MUZAFFAR.

Summary.

Measurements of the electric potential of the antimony-lead-alloys are made by means of a quadrant electrometer against a calomel electrode in normal potassium hydrate solution, normal lead nitrate, and tartar emetic with tartaric acid solutions. The results reveal an identity of potential up to 98 per cent. Sb with that of lead, which show the formation of no solid solution and no chemical compound between the two metals. This work is in agreement with the observations of Charpy, Gautier, Gontermann and Saposchnikoff, and Kanewsky.

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, THURSDAY, MARCH 1, 1923, AT 8 P.M.

The following papers were read:—

Co-ordination compounds and the Bohr Atom, by N. V. SIDGWICK.

Silver Salvarsan, by W. H. GRAY.

On the Propagation of the Explosion-wave through Gaseous Mixtures, by H. B. DIXON.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

FARADAY MEDAL.

The Council of the Institution of Electrical Engineers have made the second award of the Faraday Medal to the Honourable Sir Charles Algernon Parsons, K.C.B., F.R.S., Honorary Member of the Institution.

The medal is awarded for "notable scientific or industrial achievement in electrical engineering, or for conspicuous service rendered to the advancement of electrical science."

THE GEOLOGICAL SOCIETY.

At the Ordinary General Meeting on Wednesday, February 28, 1923, at 5.30 p.m., the following communications were read:—

The Late Glacial Stage of the Lea Valley (Third Report), by SAMUEL HAZZLEDINE WARREN, F.G.S. With a Report on the *Arctic Flora*, by MRS. ELEANOR MARY REID, B.Sc., F.L.S., F.G.S., and MISS MARJORIE ELIZABETH JANE CHANDLER.

The Elephas-antiquus Bed of Clacton-on-Sea (Essex), and its Flora and Fauna, by SAMUEL HAZZLEDINE WARREN, F.G.S. With Appendices by Dr. Charles William Andrews, B.A., F.R.S., Mrs. E. M. Reid, and Miss M. E. J. Chandler, Alfred Santer Kennard, F.G.S. and Bernard Barham Woodward, F.L.S., F.G.S., and Martin A. C. Hinton.

ROYAL MICROSCOPICAL SOCIETY.

The section of the Society formed to deal with the Industrial Applications of the Microscope, and to assist in the development of Industrial Research, met on Wednesday, February 28, 1923, at 7 p.m.

The following demonstrations and exhibits were made:—

Messrs. Charles Baker showed their R.M.S. Microscope (new model).

Mr. Conrad Beck, C.B.E., F.R.M.S., showed Mercury Globules under Polarised Light, with special reference to Dr. Owen's communication read at the last meeting.

Messrs. A. Gallenkamp & Co. demonstrated the use of the Gallenkamp Electrometric Titration Apparatus, an "end point" indicator for all Acid Alkali and Oxidation Titrations.

Messrs. Adam Hilger demonstrated an Interference Accessory for testing the Stands and Fine Adjustments of Microscopes, and also a Vertical Illuminator for the Microscopical Examination of Opaque Objects.

Messrs. Ogilvy & Co. exhibited a Silverman Illuminator for Opaque Objects and Standard Illuminator, both showing similar specimens for comparison of image.

Messrs. W. Watson & Sons, Ltd., showed a Petrological Binocular Microscope for Glass Exaination, illustrated by lantern slides.

Communications.

Dr. JAMES A. MURRAY, F.R.M.S., in the chair.

MR. HUMPHRY J. DENHAM, M.A., F.R.M.S. (British Cotton Industry Research Association), read a paper, *On Some Mounting Media for Microscopic Objects, especially for Cotton and other Hairs and Fibres, and for general Microscopical Work.*

MR. THOMAS TERRELL, JUNR., read a paper on *The Use of the Microscope in the Gas Mantle Industry.*

CORRESPONDENCE.

PERUVIAN PETROLEUM.

To the Editor of THE CHEMICAL NEWS.

SIR,—Referring to your issue of January 26, the article upon "Peru: A Land of Mystery" has interested me greatly.

Mention was made of the petroleum deposits around Callas. Although these are really quite productive, and the crude oil of sufficient calorific value to be commercially usable, nothing was mentioned of the vast subterranean fields from one hundred to two hundred and thirty miles north of Iniquitos. It has been the general opinion that these fields do not yield oil of a sufficiently high standard to cover the cost of transport to the coast. The opinion is erroneous. On small holdings, where timber is cut by machinery, most of the well-known makes of internal combustion engines are supplied with the oil in its natural state, the only processes of purification being the passing of the liquid through filters to remove suspended impurities.

The real difficulty lies mainly in the transport of the oil. From the Pestonal Region to the commencement of the coastal region there exists forest-land of almost impenetrable denseness. To convey the oil south to the Amazon would mean long and tedious journeys by river to, let us say, Pernambuco, where it would have to be reshipped.

In my opinion, however, the fields are sufficiently extensive to warrant the expense of a duct from Pestonal to Lima or Callas, where it could be linked up with the coastal fields. The construction of the necessary plant would pay for itself in time, although the initial cost would be heavy, and the construction period about 18 months.—I am, Sir, Yours, etc.,

Lowestoft, February 2. C. MELROSE.

THE RUHR AND BRITISH DYES.

FROM N. GRATTAN DOYLE, M.P.

To the Editor of THE CHEMICAL NEWS.

SIR,—Whether the commercial community approves or disapproves of the occupation of the Ruhr, that action has had one consequence which must interest not only most men of business as such, but in general the taxpayers of this country. I mean the ban upon German dyes. An embargo has been placed upon the despatch of tar, benzol and the other raw materials of Germany's dyestuffs industry; lignite, the coal substitute, has been confiscated; transport, whether by rail or Rhine, has been dislocated; and, finally, there comes the announcement that France begins to occupy German dyestuffs factories.

What is happening is not only the isolation of the Ruhr from Germany, but the isolation of Great Britain from German dyestuffs. Is is not fortunate, then, that we have already had the experience of being cut off from German dyes, first during the war, afterwards in the period of disorganisation that followed it? We know where we are; for, if the British textile trades were able, with the help of British dyes, to take the fullest advantage of that post-Armistice boom which was one of the most extraordinary in their history, they will be not less independent to-day, when tthe range of our dyestuffs is much bigger than it was then. Yet where would we have been now without the Dyestuffs Act, that has made possible an industry on which £200,000,000 worth of our country's trade depends? The enemies of our dyes policy will do well to greet in tactful silence, if not with tardy penitence, this crisis in the Ruhr which, had they been given their way, would certainly have meant a crisis in British factories.—Yours, &c., N. GRATTAN DOYLE.

House of Commons, S.W.1. February 14.

NOTICES OF BOOKS.

Questions and Problems in Chemistry, by FLOYD L. DARROW. Pp. VII. + 177. London: G. Bell & Sons, Ltd., Portugal Street, W.C. 1923. Price 3s. 6d. net.

In the preface to this collection of over 1,200 questions, the author states that the book is not intended for the use of the teacher, but primarily for the student, as a guide to the every-day preparation of his lessons.

It is certainly true, as is here stated, that many students neglect to prepare their work adequately, but it is very doubtful whether such pupils would remedy this by attempting unaided these questions.

In the main, the questions are instructive, and would stimulate interest. Some of them are beyond the reviewer's ability to answer, and the object of others, also, is not apparent.

Preliminary Experiments in Qualitative Analysis, with Special Procedures for the Systematic Detection of the Acids, by LOUIS J. CURTMAN, Associate Professor of Chemistry, Chief of the

Division of Qualitative Analysis, College of the City of New York. Second Edition. Pp. 63. New York: The Elsworth Press. 1922.

The object of this little canvas-covered book is to stimulate the students' interest in qualitative analysis by giving him a preliminary training in the various reactions subsequently utilised in the systematic procedures of qualitative analysis. The student is informed as to the object of the experiments he is to perform, and has to carry out the tests in such a way that the quantitative significance of a reaction is impressed upon him.

The author apparently considers that the systematic procedures for the detection of the metals are beyond the scope of the work, as he does not give them, although he includes, in the appendix, a very satisfactory modification of the analysis of the filtrate after the separation of the metals of the silver group. However, contrary to custom, systematic procedures for the detection of the acid radicals are included. These tables have been compiled largely as the result of investigations carried out in the author's laboratory, and are, certainly, the most outstanding feature of the book.

As a whole, the book can hardly claim to be self-supporting, and the author recommends that it should be used in connection with Baskerville and Curtman's *Qualitative Analysis*, to which numerous references are made. This is a distinct disadvantage, but nevertheless we think that any student would derive great advantage if he worked through this book and did not rest satisfied until he was able to supply a satisfactory answer to all the queries contained within its sixty odd pages. Further, we should like to suggest that many teachers might find this little book very useful as the basis of a catechism for elementary and moderately advanced students of Qualitative Analysis. F.L.S.

The Bureau of Mines and the State of Colorado have jointly issued a Bulletin, entitled *Oil-Shale, a historical, technical and economic Study*, by MARTIN J. GAVIN.

It is pointed out the State of Colorado considers its vast oil-shale deposits of particular value, and in co-operation with the U.S. Bureau of Mines, a research laboratory has been equipped at Boulder, with the object of determining the best conditions of shale distillation.

The bulletin outlines the present status of the petroleum industry, and gives the causes of increased consumption with the possible new sources of supply.

There are sections dealing with the history and nature and origin of oil-shale, the chemistry of its distillation. A good account of the Scotch industry is included, and the whole is well illustrated with numerous figures, graphs, and eighteen plates.

We have received from the British Science Guild a copy of their pamphlet, *Science in National Life*.

It is pointed out that every ounce of scientific knowledge and effort needs to be combined with industrial enterprise if we are to maintain not only our position in the world markets, but also if we are to meet the heavy expenditure incurred by the war.

The breadth, variety and value of the activities carried on in the name of science are seldom realised to the full—if they were, the whole commercial and industrial world would co-operate to encourage the development of scientific investigation and research in all its manifold ramifications. On this foundation we must build, and the foundation must be sound, substantial, and well laid if the superstructure is to compete in strength, beauty, and efficiency with that of other nations.

There is also a plate with the photographs of eight distinguished pioneers of science.

The U.S. Department of the Interior has issued a bulletin (No. 728), entitled *The Occurrence and Uses of Peat in the U.S.*, by E. K. SOPER and C. C. OSBON.

The subject is treated in a very comprehensive manner from both the geological and economic standpoint, and is well illustrated with photographs of typical peat bogs and formations in various States.

It is pointed out that peat is partly decayed and disintegrated plant debris. The salient features of the conversion of cellulose to peat are the elimination of hydrogen and oxygen as water, and of carbon and oxygen as carbon dioxide and the generation of methane.

The authors assign the formula $C_{62}H_{72}O_{24}$ to peat, and $C_{72}H_{120}O_{60}$ to cellulose, but give no evidence or authority for this.

Peat has been used in agriculture as a nitrogenous fertiliser, and as an absorbent

and disinfectant. It was used, especially during the war, as an antiseptic dressing, and in Bohemia has found application in curative "mud baths." Other uses, apart from the extensive use as inferior fuel, include that as packing material and paper making.

Chemical Engineering Catalog, 1922: Seventh Annual Edition. Pp. 1183. New York: The Chemical Catalog Co. Inc., 19, East 24th Street. Price $10.

To all categories of chemists, not only in America, but in Great Britain as well, this vast catalogue is invaluable. It is very obvious that it has not been compiled solely for individual enterprise, but more as a work of reference. Practically every requirement in chemistry is contained therein, from an 8 cc. platinum crucible to a complete factory: while sections have been added indexing a wide selection of scientific and technical books, and indicating the firms producing fine chemicals.

In the preparation of this enormous work the publishers have been fully alive to its value, and this has greatly guided them. According to the statement made by the compiling Committee, firms are availing themselves of the facilities for using more space, some reserving over 60 pages.

The Committee has been wise in advising advertisers to standardise their respective catalogues, so that anyone using the volume knows precisely where to find what he desires with a minimum of expenditure of time. The copious illustrations and cross-sectional diagrams also fall under this arrangement, tending to eliminate all superfluous data; at the same time, each reproduction is amply ticketed.

The work is certainly very fine; and it is to be hoped that those concerned in the future will do all in their power to maintain the high level reached by the compilers of the seventh edition. J.M.

BOOKS RECEIVED.

Paracelsus: His Personality and Influence as Physician and Chemical Reformer, by JOHN MAXSON STILLMAN. Pp. X. + 183. 1920. The Open Court Publishing Co., 149, Strand, W.C.2. 10s. net.

A correspondent is desirous of information concerning present prices for:—Hydrochloric acid (pure), sodium oxy chloride, sulphuric acid, and nitric acid, in ton lots.

New Patents.

This list is specially compiled for The Chemical News, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

2685—Alvord, E. B.—Process of making metal sulphides. Jan. 29.

2597—Michell & Co., J.—Manufacture of barium-hydroxide. Jan 29.

2944—Naef, E. E.—Production of compounds of sulphur with alkaline earth metals. Jan. 31.

3198—Thermal Industrial & Chemical Research Co.—Removal of matter from surface of a liquid in heat-treatment by molten metal, etc. Feb. 2.

Specifications Published this Week.

191793—Mai, Dr. A.—Process of making arsenical solutions and suspensions for insecticidal, fungicidal, preservative and like purposes.

191854—Imray, O. Y. (Chemical Industry in Basle).—Manufacture of dyestuffs of the triarylmethane series.

174599—Soc. L'Azote Francais.—Process for the production of granules of cyanamide with a high nitrogen content.

191797—Holliday & Co., Ltd., L. B.—Manufacture of a series of substituted alpha-naphthylamines and of the dyestuffs derived from them.

Abstract Published this Week.

190688—Chlorides.—Jacobson, B. H., of 1324, Quarriers Street, Charleston, West Virginia, U.S.A.

Aluminium, antimony, arsenic, iron, tin, zinc, and other chlorides: double chlorides.—In the production of anhydrous chlorides by the reaction of chlorine on a metal in the presence of bromine, as described in the parent Specification, a salt such as sodium or potassium chloride or bromide is added so as to maintain the product liquid without necessitating a high temperature or pressure. When a bromide is used it is not necessary to add free bromine. The invention is described with reference to aluminium chloride. In an example, aluminium chloride and sodium chloride are melted in a covered iron pot or rotating ball mill and aluminium and bromine are then added, the temperature being suitably 125-150° C. From time to time portions of the melt are drawn off, and more aluminium and salt are added and, when necessary, some additional bromine. The product withdrawn may contain 5 to 30 per cent. of sodium chloride, but is suitable for use in the Friedel-Crafts reaction. If the temperature is maintained at 200° C., aluminium chloride alone is volatilized and is recovered in a condenser.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3282.

NOVEL RESEARCH NARRATIVES.

The British Non-Ferrous Metals Research Association has hit upon a rather ingenious way of communicating the results of its research investigations to its members. Lectures are arranged at one or more centres, to which as a rule only the members of the Association itself are admitted. Two objects are served in this manner, firstly early confidential communication of the results of the research is assured to those who have given it financial support, and secondly the investigator gets into close and immediate contact with that section of the industry chiefly interested in his work.

In this manner the future direction of work and the relative practical importance of its varied issues is subjected to the mutual consideration of researcher and the industry.

The Non-Ferrous Metals Research Association is at present engaged on some ten investigations, all of which are closely connected with different branches of the metals and engineering trades.

So far the private lecture system has been applied to two subjects. Dr. W. Rosenhain, F.R.S., has reported on the investigation on Copper and the influence upon its properties of small quantities of impurities, which is being carried out for the Association by Dr. D. Hanson and others at the National Physical Laboratory. This research promises to be of fundamental importance to the copper and brass industry, and most of the leading firms are supporting the work and eagerly take advantage of opportunities, such as this lecture afforded, of hearing the results achieved.

Another large attendance of members was occasioned by the lecture on "The cause and prevention of Red Stains on Brass," by Mr. E. A. Bolton, M.Sc., describing work on this troublesome difficulty which he is carrying out at the Birmingham University—another subject of great practical interest.

The Association arranged a third lecture, given both in Birmingham and Sheffield, by Mr. Dartrey Lewis, M.Met., on his work on "Materials used for the Abrasion and Polishing of Metals." In view of the wide interests covered, a limited number of tickets was issued to non-members. The Birmingham lecture was held on Monday evening, February 26th, at 7.30 p.m., and the Sheffield lecture on Friday afternoon, February 23rd, at 2.30 p.m.

NETHERLANDS INTERNATIONAL GAS EXHIBITION.

In connection with the International Gas Exhibition which the Municipal Authorities of Amsterdam are organising. and which is to be held in that city from October 13 to November 11, 1923, H.M. Consul-General at Amsterdam has forwarded to the Department of Overseas Trade copies of the rules and regulations of the exhibition, together with forms of application for space.

It is the intention to collect exhibits demonstrating the use of gas for industrial purposes in large and small concerns, *e.g.*, metal works, chemical works, food preserving factories, restaurants, cycle factories, vulcanising plants, central heating systems, for the practical use of doctors, dentists, bakers, etc. Household and scientific appliances employing gas as fuel will also be welcomed.

British firms interested may inspect the rules, etc., on application to the Department of Overseas Trade (Enquiry Room), 35, Old Queen Street, Westminster, London, S.W.1. A few copies are available for loan to firms unable to arrange for an inspection in London. Ref., 7808/FB/GP).

REPORT OF THE INTERNATIONAL COMMITTEE ON CHEMICAL ELEMENTS (1923).

CONSTITUTION OF THE COMMITTEE.

The *International Committee on Atomic Weights* takes its instructions from the International Association of Chemical Societies which was dissolved during the great war and replaced by the *International Union of pure and applied Chemistry.*

During the second Conference, held at Brussels on June 30, 1921, the *International Union of pure and applied Chemistry* decided to replace the *International Committee on Atomic Weights* by an *International Committee on Chemical Ele-*

ments. The scope of the new Committee is more extended than that of the old Committee. The discovery of Isotopy *first in the domain of radioactive Elements*, later in that of non-radioactive Elements, produced new problems not only concerning Atomic Weights, but also affecting the conception of a chemical Element.

In consequence, the *International Union* has decided that it should be the duty of the new Committee to keep chemists informed of the various advances made each year in this field already rich and so full of promise for the future.

The Committee will therefore prepare three tables: one Table of radioactive Elements containing their principal constants; one Table of Isotopes; one Table of Atomic Weights.

The *International Union* has decided that the Committee should consist of at the most 12 members, and it has itself elected 7 of these: MM. Aston (Great Britain), Brauner (Czecho-Slovakia), Debierne (France), Ph. A. Guye (Switzerland), Richards (United States of America), Soddy (Great Britain), Urbain (France).

It has appointed as experts for the year 1922 MM. Baxter (United States of America) and Moles (Spain). MM. Clarke and Thorpe are honorary presidents.

The Committee, to complete itself, has, in consequence of the regrettable death of Ph. A. Guye, elected MM. Baxter (United States of America) and Leduc (France). In accordance with its statutes the Committee has invited all the national branches of the *International Union* to create in their countries national Committees from which it may receive notice on any question connected with its activities.

Three of these national Committees are actually working, in Spain, France and Switzerland.

Work of the Committee During the Year 1921-1922.

The Committee has prepared the two tables, of which the need was particularly felt: a Table of radioactive Elements, and a Table of Isotopes.

The work of the Committee is not complete as regards the Table of Atomic Weights, which will be published later on. As a result the Table for 1922 drawn up by the old *International Committee for Atomic Weights* is accepted for 1923. It is on this account that the values which appear in the Table of Isotopes under the title *Atomic Weights* are these given in the International Table for 1922.

In the case of the radioactive Elements the figures appearing under the title *Atomic Mass* are the values, rounded to the nearest whole number, from the Atomic Weights of Uranium (Uranium I), Thorium and Radon (Radium Emanation).

The Committee has found it necessary to modify the nomenclature of several radioactive Elements.

Each of the Tables is accompanied by notes which explain the signs, symbols and new names adopted by the Committee.

The Committee consider that, as regards the radioactive Elements and Isotopes, its work is only provisional. It recognised that the definitions and nomenclatures which have been adopted do not form a homogeneous whole. Until a general reform of the nomenclature of the radioactive Elements is under consideration it has respected as far as possible the names given by the discoverers. On this account, before adopting for the three emanations the names Radon, Actinon and Thoron, the approval of Mme. Curie and Sir E. Rutherford was obtained.

The Committee hopes that the new International Tables will be favourably received by the scientific world, and that the values adopted will be generally approved.

F. W. Aston.
Gregory P. Baxter.
Bohuslav Brauner.
A. Debierne.
A. Leduc.
T. W. Richards.
Frederick Soddy.
G. Urbain.

International Table of Isotopes (1923).

Atomic Number.—*A chemical element* is defined by its *atomic number*. This number represents the excess of positive over negative charges in the constitution of the atomic nucleus; theoretically the *atomic number* represents also the number of electrons which rotate round the central positive nucleus of the atom. Each *atomic number* also represents the place occupied by the element in the Mendeléef Table.

Various methods have been suggested to determine the *atomic numbers*. The most important of these consists in deducing them from the wave-lengths of the high frequency spectra by applying Moseley's law.

Elements (simple and complex). Isotopes.—If the above definition is accepted, each chemical element may be *simple* or *complex*, according as its atoms are all of equal mass or not.

In the latter case, the element consists of as many *isotopes* as its *atoms* have different *masses*. A *complex* element is a *mixture of isotopes*. Three methods (J. J. Thomson, Aston, Dempster) have been devised to determine isotopes. The most important is that of Aston.

Notation. — The elements, simple or complex, are represented by the ordinary symbols. To indicate any particular isotope its atomic mass[1] is written as an index to the right of the symbol representing the mixture. Thus, Cl^{35} indicate the isotope of chlorine having an atomic mass 35. This number represents the relative mass of its atom, the atom of oxygen (a simple element) being taken as 16.

Elements included in the Table. — The isotopes of lead which are the ultimate result of disintegration of radioactive Elements, and the radioactive isotopes will only appear in the International Table of the radioactive Elements. Only those elements appear in the Table of Isotopes which are recognised as simple, or are complex elements whose isotopes have been determined with sufficient certainty.

Provisional Values. — Numbers in brackets are to be taken as provisional only.

TABLE OF ISOTOPES.

Element	Atomic number	Atomic Weight	Minimum Number of Isotopes.	Masses of Isotopes	% Accuracy	Observer
H	1	1.008	1	1.008	0.2	A.
He	2	4.00	1	4		A.
Li	3	6.94	2	7 ; 6		A., T., D.
Gl	4	9.1	1	9		T.
B	5	10.9	2	11 ; 10	0.1	A.
C	6	12.005	1	12		A.
N	7	14.008	1	14	0.2	A.
O	8	16.000	1	16		A.
F	9	19.0	1	19	0.1	A.
Ne	10	20.2	2	20 ; 22	0.1	A.
Na	11	23.00	1	23		A.
Mg	12	24.32	3	24 ; 25 ; 26		D.
Al	13	27.0	1	27		A.
Si	14	28.1	2	28 ; 29 ; (30)	0.1	A.
P	15	31.04	1	31	0.2	A.
S	16	32.06	1	32	0.2	A.
Cl	17	35.46	2	35 ; 37	0.1	A.
A	18	39.9	2	40 ; 36	0.1	A.
K	19	39.10	2	39 ; 41		A.
Ca	20	40.07	(2)	40 ; (44)		D.
Fe	26	55.84	(1)	56 ; (54) ?		A.
Ni	28	58.68	2	58 ; 60	0.1	A.
Zn	30	65.37	4	64 ; 66 ; 68 ; 70		D.
As	33	74.96	1	75	0.1	A.
Se	34	79.2	6	80; 78; 76; 82; 77; 74	0.1	A.
Br	35	79.92	2	79 ; 81	0.1	A.
Kr	36	82.92	6	84; 86; 82; 83; 80; 78	0.1	A.
Rb	37	85.45	2	85 ; 87		A.
Sn	50	118.7	7 (8)	120 ; 118 ; 116 ; 124 119 ; 117 ; 122 ; (121)		A.
I	53	126.92	1	127	0.2	A.
Xe	54	130.2	7 (9)	129; 132; 131; 134; 136; 128; 130; (126); (124)	0.1	A.
Cs	55	132.81	1	133		A.
Hg	80	200.6	(6)	(197-200) ; 202 ; 204	0.1	A.

Observers**:** A = Aston, D = Dempster, T = Thompson (G.P.)

International Table of the Radioactive Elements and Their Constants.

T	Name	Symbol	Atomic Wt.	Atomic No.	Isotope	Radiation
	Series of Uranium and Radium.					
4.67 × 10^9 years	*Uranium I*	UI	238	92	U	α
24.6 days	*Uranium X_1*	UX_1	234	90	Th	β
1.15 minutes	*Uranium X_2*	UX_2	234	91	Pa	β (γ)
2 × 10^6 years	*Uranium II*	UII	234	92	U	α
6.9 × 10^4 years	*Ionium*	Io	230	90	Th	α
1690 years	*Radium*	Ra	226	88	Ra	α (β+γ)
3.85 days	*Radon*	Rn	222	86	Rn	α
3.0 minutes	*Radium A*	RaA	218	84	Po	α
26.8 minutes	*Radium B*	RaB	214	82	Pb	β (γ)
19.5 minutes	*Radium C*	RaC	214	83	Bi	99 97% β & γ
10^{-6} second	*Radium C'*	RaC'	214	84	Po	α
16.5 years	*Radium D*	RaD	210	82	Pb	(β and γ)
5.0 days	*Radium E*	RaE	210	83	Bi	β
136 days	*Radium F* (Polonium)	RaF (Po)	210	84	Po	α (γ)
....	*Radium Ω'* (Lead)	RaΩ' Pb^{206}	206	82	Pb	....
....	*Radium C*	RaC	214	83	Bi	0.03% α
1.4 minutes	*Radium C″*	RaC″	210	81	Tl	β
....	*Radium Ω″*	RaΩ″	210	82	Pb	....
	Series of Actinium.					
....	*Uranium ?*	....		92	U	α
1.04 days	*Uranium Y*	UY		90	Th	β
1.2 × 10^4 years	*Protoactinium*	Pa		91	Pa	α
20 years	*Actinium*	Ac		89	Ac	—
19.5 days	*Radioactinium*	RdAc		90	Th	α (β)
11.4 days	*Actinium X*	AcX		88	Ra	α
3.9 seconds	*Actinon*	An		86	Rn	α
2.0 × 10^{-3} second	*Actinium A*	AcA		84	Po	α
36.1 minutes	*Actinium B*	AcB		82	Pb	(β and γ)
2.15 minutes	*Actinium C*	AcC		83	Bi	α
4.71 minutes	*Actinium C″*	AcC″		81	Tl	β and γ
....	*Actinium Ω″*	AcΩ″		82	Pb	....
	Series of Thorium.					
1.31 × 10^{10} years	*Thorium*	Th	232	90	Th	α
6.7 years	*Mesothorium 1*	MsTh1	228	88	Ra	—
6.2 hours	*Mesothorium 2*	MsTh2	228	89	Ac	β and γ
2.02 years	*Radiothorium*	RdTh	228	90	Th	α (β)
3.64 days	*Thorium X*	ThX	224	88	Ra	α
54 seconds	*Thoron*	Tn	220	86	Rn	α
0.14 second	*Thorium A*	ThA	216	84	Po	α
10.6 hours	*Thorium B*	ThB	212	82	Pb	β and γ
60 minutes	*Thorium C*	ThC	212	83	Bi	65% β
10^{-11} second	*Thorium C'*	ThC'	212	84	Po	α
....	*Thorium Ω'* (Lead)	ThΩ' Pb^{208}	208	82	Pb	....
....	*Thorium C*	ThC	212	83	Bi	35% α
3.1 minutes	*Thorium C″*	ThC″	208	81	Tl	β and γ
....	*Thorium Ω″* (Lead)	ThΩ″ Pb^{208}	208	82	Pb	....
[illegible]	[illegible]	[illegible]	[illegible]	19	K	β

REMARKS ON THE INTERNATIONAL TABLE OF THE RADIOACTIVE ELEMENTS AND THEIR CONSTANTS.

It is desirable that the nomenclature adopted by the International Commission should be universally accepted, but that now put forward is provisional, serving as a basis for discussion before the ultimate adoption of a standard nomenclature.

T stands for the time in which the quantity of radio-element is diminished to one-half. Under *Radiation*, the brackets ( ) indicate that the radiation is relatively feeble.

[1] *The expression "atomic mass' is reserved for isotopes or simple elements considered from the isotopic point of view The expression* ATOMIC WEIGHT *retains its usual meaning, and is applied to elements without consideration of their isotopic constitution.*

CATALYST POISONING.

At the Chemical Society of the University of Birmingham, on February 19—Professor Morgan presiding—Dr. Edward B. Maxted, chairman of the Birmingham and Midland Section of the Society of Chemical Industry, read a paper on "Catalyst Poisoning."

Poisoning may be specific rather than general, the author pointed out, for what is a poison for a given reaction with a given catalyst may be harmless for a second reaction with even the same catalyst or even for the same reaction with a different catalyst.

The following is a summary of Dr. Maxted's remarks:—

1. Catalyst poisoning consists of the preferential adsorption of the poison by the catalyst, in such a way that the secondary valencies of the catalyst, in place of being free for transitory association with the normal reacting system—the probable mechanism of ordinary catalysis—are obstructively saturated by the poison. By obstructively saturated is meant that the free evaporation of the adsorbed poison from the surface of the catalyst and its replacement by the normal reacting system does not take place—or, at all events, not readily.

2. *From the above, it follows that* if a given inhibitant poisons a given catalyst, then the catalyst will adsorb the poison. The adsorption of a poison by a preliminary charge of catalyst may in some instances be used to purify a reacting system; but in most cases the amount actually removed by a given weight of catalyst is too small for the method to be used practically.

3. The activity of a catalyst during the first stages of poisoning is a linear function of the poison content, and the form of the poisoning curve is intimately connected with that of the adsorption curve.

4. The general type of the reaction curve is not affected by the presence or absence of a poison insufficient in quantity or the complete suppression of activity, provided that the concentration of the poison on the surface of the catalyst does not change during the reaction, and provided also that the form of the catalyst does not change.

DECOMPOSITION OF FORMIC ACID BY SULPHURIC ACID.

By E. R. SCHIERZ.

Sulphuric acid decomposes formic acid with the evolution of carbon monoxide, and the velocity of the reaction decreases with addition of water. The reaction is considered to be one of dehydration, an explanation of which is suggested in the equation:—

$$n\ H\text{-}C(O)\text{-}OH + m\ H_2SO_4 \rightarrow N\ CO + m\ H_2SO_4.nH_2O.$$

The effects of other substances on the re-

action have been studied, and whereas both acetone and acetic acid act as diluents, not actually decreasing the dehydrating power of sulphuric acid, if the volume of acetic acid is great, *i.e.*, 1 vol. H_2SO_4 to 10 vols. CH_3COOH, the formic acid is not decomposed. On the other hand, hydrogen chloride increases the velocity of the reaction. Again, copper, silver, and other sulphates decrease slightly the velocity of reaction.—(*Jour. Amer. Chem. Soc.*, 1923, p. 447.)

STABILITY OF SODIUM OXALATE SOLUTION.

By E. S. Hopkins.

In laboratories where oxygen absorption estimations are made, it is frequently the custom to titrate back the excess of permanganate with $\frac{N}{100}$ sodium oxalate solution. It has been found that this latter is not at all stable, but can be rendered so by the addition of 100 cc.s of 1:4 H_2SO_4 to the litre of $\frac{N}{100}$ oxalate when being made up. Such solution will not deteriorate for two months, even when exposed to daylight in an ordinary colourless glass bottle. —(*Jour. Ind. Eng. Chem.*, 1923, p. 149.)

In his annual report for 1922, George M. Cassatt, President of the American Chamber of Commerce, stated that during 1922 the Chamber continued to use every possible means at its disposal to increase the sale of British products in the United States as well as American goods over here, and in spite of adverse circumstances the results of its efforts demonstrate its importance as a factor in Anglo-American business.

NOTICES AND PROCEEDINGS OF SOCIETIES.

THE ROYAL SOCIETY.

Papers read on Thursday, March 1, 1923, at 4.30 p.m.:—

A. Mallock, F.R.S. *The Effect of Temperature on some of the Properties of Steel.*

In this paper experiments are described in which the period of torsional vibration and the length of a steel wire were automatically and continuously recorded in terms of time, while the temperature was varied between 15° and 1,000° C., the temperature also being recorded.

From the experiment the variation of rigidity and the coefficient of temperature expansion between these limits can be deduced.

The results show (1) that the variation of the rigidity of steel between ordinary temperature and a dull red heat is small (less than 1 per cent.); (2) that above the critical temperature (about 800° C.) the rigidity decreases rapidly; (3) that the temperature coefficient of expansion does not show any marked change as the metal passes through the critical temperature; but (4) that a comparison with the cooling curves of iron and steel (alluded to in the paper) proves that the specific heat of the high temperature form of the metal is much less than it is at temperatures below the critical point.

Prof. C. H. Lees, F.R.S. *Inductively Coupled Low-Resistance Circuits.*

It is shown that the oscillations in each of two circuits of low resistance coupled by their mutual inductance can be simply expressed in terms of a certain product of capacitance and inductance. The expressions for the currents lead to a simple graphical solution of the problem.

Lord Rayleigh, F.R.S. *Studies of Iridescent Colour, and the Structure producing it. I.—The Colours of Potassium Chlorate Crystals.*

The structure of the iridescent potassium chlorate crystals investigated by Stokes and the late Lord Rayleigh is examined microscopically.

The periodic twinned structure inferred by the latter is clearly shown in the photographs taken under the microscope with polarised light.

Some crystals have exceedingly complex structure, showing many groups of evenly spaced twin planes and a very complex reflection spectrum. It is shown that this results from high interference from twinned layers situated a considerable distance apart.

Chlorate crystals, giving a silvery reflection, were obtained by Madan, who heated the ordinary colourless crystals to about

250° C. The complex twinned structure induced by this treatment is investigated, and photographs of the structure of the crystal and of the reflection spectrum are reproduced. There are corresponding irregularities in each, resulting from want of flatness in the twin planes.

LORD RAYLEIGH, F.R.S. *Studies of Iridescent Colour, and the Structure producing it. II.—Mother-of-Pearl.*

The structure giving rise to the colour of mother-of-pearl was investigated. The results generally are confirmatory of those given by Brewster and A. H. Pfund. Micro-photographs were reproduced showing the grating structure of a pearl oyster shell and the structure of parallel layers of an "ear" shell. The absorption spectrum of the latter was also reproduced. In agreement with the observed spacing of the layers under the microscope, it shows the reflection to be of the second order.

LORD RAYLEIGH, F.R.S. *Studies of Iridescent Colour, and the Structure producing it. III.—The Colours of Labrador Felspar.*

The colours shown by Labradorite felspar were examined experimentally. The colours seen by reflection arise from two distinct origins:—

(1) Specular reflection from tabular inclusions, which show the colours of thin plates and are often as much as 0.2 mm. in dimensions. These are distributed parallel to one of the cleavages.

(2) Diffuse reflection from a plane 15° away from the cleavage mentioned. This is the source of the striking colours which ordinarily excite attention.

When the diffuse reflecting plane is examined microscopically under conditions which ensure that the light only comes from a very thin stratum, it is found that the plane of reflection is discontinuous or patchy. The patches are of irregular outline.

The diffuse character of the reflection is accounted for by the small diameter of these reflecting surfaces, regarded as independent optical apertures. Their size (0.005 mm.) accounts approximately for the angular diameter of the diffuse image of a point source seen by reflection, if we regard this as a diffraction disc. This explanation requires that the reflecting patches, though parallel, should not be strictly co-planar, but distributed at random depth.

The colour of the reflection is not sharply limited to special regions of the spectrum, and it appears that the colour can be explained by the interference of streams of light from the two surfaces of each patch. The patches may be fissures in the material, and there is evidence that their thickness is not absolutely uniform.

The brightness of the colour is explicable by the large number of reflecting patches adding their effects, without definite phase relation such as would give rise to regular interference.

Micro-photographs of the structure giving rise to the two reflections are reproduced.

Paper read in title only:—

L. V. KING, D.Sc. *On the Complex Anisotropic Molecule in Relation to the Dispersion and Scattering of Light.* Communicated by Prof. A. S. Eve, F.R.S.

THURSDAY, MARCH 8, AT 4.30 P.M.

Papers read:—

A. B. WOOD, H. E. BROWNE, and C. COCHRANE. *Determination of Velocity of Explosion Waves in Sea Water. Variation of Velocity with Temperature.* Communicated by F. E. Smith, F.R.S.

P. M. S. BLACKETT. *The Study of Forked Alpha Ray Tracks.* Communicated by Sir Ernest Rutherford, F.R.S.

E. HATSCHEK and P. C. L. THORNE. *Metal Sols in non-dissociating Liquids. I.—Nickel in Toluene and Benzene.* Communicated by Prof. A. W. Porter, F.R.S.

Papers read in title only:—

H. HIRATA. *Constitution of the X-Ray Spectra belonging to the L Series of the Elements.* Communicated by Sir William Bragg, F.R.S.

A. EGERTON. *On the Vapour Pressure of Lead. I.* Communicated by Prof. F. A. Lindemann, F.R.S.

A. C. EGERTON and W. B. LEE. *Some Density Determinations.* Communicated by Prof. F. A. Lindemann, F.R.S.

A. C. EGERTON and W. B. LEE. *Separation of Isotopes of Zinc.* Communicated by Prof. F. A. Lindemann, F.R.S.

THE SOCIETY OF GLASS TECHNOLOGY.

Prof. W. E. S. Turner, D.Sc., presided at the meeting held in Armstrong College, Newcastle-on-Tyne, on February 21.

The first paper was: *Organising for Production from Pot Furnaces*, by W. W. WARREN, A.M.I.C.E., A.M.I.E.E. (Manager of Messrs. Lemington Glass Works, Ltd.). The subject was approached from experience gained at Lemington, where methods for producing electric lamp bulbs from pot furnaces were modelled on those in German and Dutch glass works.,

Comparing present practice at Lemington with that of 1918, when the output of hand-made pulbs was similar in number and weight, there were now only 20 pots in commission, as against 70 pots in 1918. This intensifying of production had effected an enormous saving of coal. Fuel costs were less then than in pre-war times.

During the forenoon. a party of members of the Society visited the glass works at Lemington, and saw in actual operation the scheme outlined by Mr. Warren.

Two other papers were communicated: *The Effect of Boric Oxide on the Melting and Working of Glass*, by F. W. HODKIN, B.Sc., and PROF. W. E. S. TURNER, D.Sc., and *Some Physical Properties of Boric Oxide-containing Glasses*, by VIOLET DIMBLEBY, B.Sc., S.ENGLISH, M.Sc., and PROF. TURNER.

Boric oxide glasses were of great importance. Although boric oxide had been used as a constituent of glass for at least a century, it assumed greater importance from the German researches at Jena forty years ago. Lately, borosilicate glasses had been more in use. The new British chemical glass, American Pyrex glass for chemical and cooking ware, and various illuminating glasses, all contained it. Investigations, designed to lay down a foundation of facts concerning such glasses, were outlined.

Addition of boric oxide to silicate glass increased the durability, but this beneficial effect only held up to a certain point, the maximum benefit for the glass with 20 per cent. of soda being obtained at 11 to 12 per cent. of boric oxide. Glass then became less durable, until when 35 to 40 per cent. was present it dissolved in water. Again, reduction in thermal expansion reached a maximum effect at about 20 per cent. of boric oxide in both series of glasses. The usefulness of boric oxide was limited, and further experiments of the heat-resisting glasses must lie in other directions than the employment of boric oxide. Inversions in annealing temperature, the density, and refractive index, had also been found at the Department of Glass Technology of Sheffield University.

ROYAL INSTITUTION OF GREAT BRITAIN.

At 3 p.m., on Saturday, March 10, SIR ERNEST RUTHERFORD, LL.D., D.Sc., F.R.S., M.R.I., Prof. of Natural Philosophy, will deliver his fourth lecture on *Atomic Projectiles and their Properties.*

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The next meeting of the Society will be held on Wednesday, March 7, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., at 8 p.m.

The following papers will be read.

The Examination of Firearms and Projectiles, by A. LUCAS, O.B.E., F.I.C.

The Interpretation of the Results obtained in the Analysis of Potable Waters, by R. C. FREDERICK.

Determination of the Purity of Vanillin, by SYDNEY B. PHILLIPS, A.I.C.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

WIRELESS SECTION MEETING.

MR. H. MORRIS-AIREY, C.B.E., gave a lecture entitled *The Development of Naval High Power Valves* on March 7.

THE OPTICAL SOCIETY.

At the meeting held on Thursday, 8th March, the following papers were read:—

Optical designing as an Art, by H. DENNIS TAYLOR.

The distribution of correction duties in Optical Instruments, by T. SMITH, M.A., F.INST.P.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The tenth annual general meeting of the Institution of Petroleum Technologists

will be held at the house of the Royal Society of Arts on Tuesday, March 13th, at 5.30 p.m., and will be followed at about 6 p.m. by a Presidential Address by Professor J. S. S. Brame, F.I.C., F.C.S., the retiring President.

The President-elect for the ensuing session is Mr. Herbert Barringer, M.Inst.C.E., M.I.Mech.E., M.I.N.A., and the Vice-Presidents are Mr. Alfred C. Adams, Sir George Beilby, Sir John Cargill, Viscount Cowdray of Cowdray, Mr. Arthur W. Eastlake, and Sir Thomas H. Holland.

INSTITUTE OF CHEMISTRY.

At the 45th Annual General Meeting of the Institute of Chemistry, held at 30, Russell Square on March 1, the President, Mr. A. Chaston Chapman, F.R.S., in presenting the Report of the Council, remarked on the progress of the organisation of the profession of chemistry under the Institute. The roll of Fellows and Associates had increased during the past twelve months by 421, to a total of 4,062, and the register of students by 72, to a total of 955.

The Institute was taking an increasing part in the affairs of the country, and was frequently appealed to by Government Departments and other authorities for advice and help. Natural Science—and in this connection chemistry must be given a position of prominence—was by far the most important dynamic factor in human progress. Notwithstanding its liability to abuse, its discoveries had made enormously for the greater good and happiness of the human race. Science was coming into its own, and scientific men would be given their proper status and rightful place in the affairs of the country. The Institute, in common with other societies and associations, was actively promoting a spirit of solidarity among all concerned with chemistry.

The direct utilisation by the State of the services of the professional chemist was a matter not only of immediate concern to chemists themselves, but was of high importance to the community, and in the country's interests no less than in those of its members, the Institute was bound to do all it could to ensure that the relations between the appointing authorities and those who held official chemical positions were satisfactory. Unfortunately, some public bodies did not appear to be aware of the lengthy and expensive nature of the chemist's training, or of the difficulties and responsibilities connected with his work, and consequently the Institute sometimes found the advertised conditions of certain public bodies were not commensurate with the importance of the services demanded. The mere saving of money was not always identical with true economy, and it was clearly of public importance that men of good general education, of high professional attainments, and of high moral character should be chosen to fill these positions, while it was obvious that appointing authorities would seriously limit the field for selection, unless the conditions offered were such that men of the right class would be willing to accept. For the appointment of public analyst the remuneration offered was often entirely inadequate and, in some cases, even below that paid before the war.

The Institute had also been obliged to complain of the competition of state-aided institutions with private practitioners, and it was a source of gratification that the Ministry of Agriculture and Fisheries had recognised the legitimate grievance of the private practitioner, and had taken steps towards limiting the agricultural work done in the institutions receiving its grants to that required for strictly educational purposes or necessary to the advisory work of the institutions.

The disinterested zeal of the scientific worker was something without parallel in the whole world, but it was not wise for any country to presume too much on this disinterestedness. Science was one of the greatest and freest of all givers, but it had a right to demand that it should receive that recognition and that proper position in the councils of the country to which it was entitled.

A leading German industrial chemist had said lately that, notwithstanding Germany's position of virtual bankruptcy, the State had come to the help of the great chemical and physical societies, like the Kaiser Wilhelm Institute, and if the State could not continue financial aid the German people themselves must give their last mark to maintain science.

Referring to the prospects of the profession, the President said chemistry had great attractions for most boys, and there were many induced by a liking begotten in

the school laboratory to embark upon a profession for which they had perhaps no real aptitude. A chemical career was not *a succession of fascinating experiments,* but it involved a good deal of hard work of a comparatively unattractive character, made very great demands on its devotees, and called for much self-sacrifice on the part of those who adopted it as a profession. The profession had attracted a larger *number of young men during the last four* years than in any previous corresponding period, but he was optimistic in regard to the future. It was a remarkable fact that, notwithstanding industrial depression, the new members of the profession were being steadily absorbed. This absorption might *be taken as an indication that chemistry* was more highly valued by manufacturers than formerly. Leaders of industry were turning more to science to assist them in solving their problems.

The Report of the Council and Financial Statements were received and adopted, *and the officers, Council, and censors for* the ensuing year were elected.

The Meldola Medal was awarded, for the second time, to Dr. Christopher Keik Ingold.

SOCIETY OF CHEMICAL INDUSTRY.

Birmingham and Midland Section.

At the meeting on February 20, the following papers were delivered:—

Interaction of Formaldehyde and the Nitronaphthylamines, by Professor Gilbert T. Morgan (Head of the Chemical Department of the University), and F. R. Jones.

The authors state that the seven known nitronaphthylamines have been condensed with formaldehyde under varying conditions: — 4-nitro-α-naphthylanine and 2-nitro-α-naphthylamine give dinaphthylmethane bases; 1-nitro-β-napbthylamine furnishes the hydrolysable methylenebis—1-nitro-β-naphthylamine, which exists in two differently coloured modifications; 5-nitro-β-naphthylamine gives rise to two products, a dinaphthylmethane base and a dinaphthacridine; 8-nitro-β-naphthylamine gives methylenebis-8-nitro-β-naphthylamine, which becomes transformed into a dinaphthylmethane base; 5-nitro-α-naphthylamine resembles α-naphthylamine in yielding ill-defined products, whereas 8-nitro-α-naphthylamine furnishes methylenebis-8-nitro-α-naphthylamine and a dinaphthylmethane base which has the noteworthy property of separating in yellowish white tabular crystals containing three molecular proportions of formaldehyde.

These results show that the nearer the nitro-group is to the amino-radicle in the nitronaphthylamine the more marked is the *retarding effect of this nitro-group on the* condensation with formaldehyde.

Note on the Preparation of β-Naphthol-4-sulphonic Acid, by Professor Morgan and Eveline Jones.

An attempt has been made to obtain *β-naphthol-4-sulphonic acid from the* commercially available naphthalene-1-diazo-2-oxide-4-sulphonic acid by boiling this diazo-compound with alcohol, when elimination of the diazo-group occurs, the resulting β-naphthol-sulphonic acid being characterised by means of its azo-derivatives with the di*azonium salts of p-toluidine, p-nitroaniline* and β-naphthylamine.

S. R. Carter, M.Sc., Chemistry Department of the University, read a paper on the *Concentration of Hydrogen Ion.* The advantages of reducing all degrees of acidity and alkalinity to one common scale were demonstrated, and the basis of Sörensen's Hydrogen Ion experiment (P_h) was explained. The constitution of indicators was discussed and their application to the determination of P_h values was illustrated by experiments. The latter portion of the lecture was devoted to the electro metric methods employed for hydrogen ion measurements, and to electro metric titrations and the principles involved were illustrated by reference to potentiometers and electrodes lent by the Cambridge and Paul Instrument Co.

GENERAL NOTES.

VERTICAL RETORTS AND CHEMICAL PROBLEMS.

Mr. Joseph Poulson, F.C.S. (Stafford Corporation Gas Works) read a paper on "Experiences of Vertical Retorts," before the members of the Midland (Junior) Gas Engineers, at the Birmingham Council House, on Thursday, January 14. He gave

the following particulars of the tar produced:—

Per ton of coal carbonised ... 17.3 gallons.
Specific gravity of tar 1.095
Water content of tar .... 3.5 per cent.
Free carbon in tar .... 3.1 per cent.

Sulphate of Ammonia. — Twenty-three lbs. of neutral dry quality, testing 25½ per cent. of ammonia are obtained per ton of coal carbonised. Ammonia is at present allowed to go forward to the purifiers to assist in purification.

Since the commencement of operation of the vertical retorts, the district has been remarkably free from naphthalene, and there has not been recorded one single complaint from this cause for over 3½ years. The naphthalene content of the gas is 0.85 grain per 100 cubic feet. The freedom from such deposit has permitted the installation of a station meter of the Rotary type, but further information regarding this is not yet available, the meter having been in operation only a few months.

No pitching troubles have been experienced. The collecting mains are run off daily, and before opening the valve to effect this, any accumulation of thickened matter that has drained to the exit end of the main is scooped out. The amount of thick tarry matter obtained from each main daily averages 14 to 16 lbs. The period of draining of each main is about three-quarters of a minute. After closing the draining valve, the collecting main is then filled to the level of the weir overflow with warm and weak liquor supplied from an overhead tank. The temperature of the gas from the retorts is 185° C., and of the gas, near the outlet of the collecting main, 118° C.

As to the refractory materials used in the settings, he stated that examination of the materials proved them to be remarkably true to size and shape. The surfaces were smooth, and edges well defined. The fracture of portions of the various segments revealed a uniformity of texture. Small nodules of unconverted quartz were evenly disseminated throughout the mass. The materials used in the construction of the floors of the combustion chambers were of close texture, and the strength of the materials was good, when taking into consideration their composition. The following are analyses of the various portions used:—

SILICA RETORT SEGMENTS.

	per cent.
Silica	89.27
Titanic Oxide	0.77
Alumina	8.53
Ferric Oxide	0.84
Manganese Oxide	—
Magnesia	0.23
Lime	—
Potash	0.20
Soda	0.30
Loss	0.05

COMBUSTION CHAMBERS.

	per cent.
Silica	91.60
Titanic Oxide	0.46
Alumina	6.32
Ferric Oxide	0.30
Manganese Oxide	—
Magnesia	0.21
Lime	0.26
Potash	0.85
Soda	0.18
Loss	0.09

ORDINARY SILICA BRICKWORK.

	per cent.
Silica	87.23
Titanic Oxide	1.85
Alumina	8.55
Ferric Oxide	1.25
Manganese Oxide	—
Magnesia	0.10
Lime	0.28
Potash	0.54
Soda	0.36
Loss	0.25

H.M. Commercial Secretary at Copenhagen (Mr. Richard Turner, O.B.E.) reports that a well established local firm is desirous of setting up a permanent exhibition on behalf of ten or twelve United Kingdom firms manufacturing:

Scientific instruments.
Surgical instruments.
Cinematograph apparatus.
Laboratory articles.
X-Ray apparatus and tubes.
Dentists' requisites.
Surveying instruments.
Drawing instruments.
Polariscopes.
Pyrometers and measuring instruments.
Microscopes.
Telescopes.

Further particulars regarding this proposition can be obtained by interested firms on application to the Department of *Overseas Trade, 35, Old Queen Street*, Westminster, S.W.1.

SAFEGUARDING OF INDUSTRIES ACT—PART I.

ARBITRATIONS UNDER SECTION 1, SUB-SECTION (5).

The Board of Trade have received formal notices of complaint under the above sub-section, that:

"Rochelle Salts" and
Formaldehyde

have been improperly included in the lists of articles chargeable with duty under Part I. of this Act.

These complaints will be submitted in due course to the Referee appointed by the Lord Chancellor for the purposes of the sub-section, and any person interested should communicate immediately with the Assistant Secretary, Board of Trade (Industries and Manufactures Department), Great George Street, S.W.1.

NORWAY'S FOREIGN TRADE.

The Commercial Secretary at Christiania has informed the Department of Overseas Trade that the statistics of Norwegian foreign trade, published by the Statistical Central Bureau, for the month of December, 1922, show the total of Norwegian exports during the past year to have amounted to 729.4 million kroner, and the re-export of foreign goods to 24.4 million kroner. Of Norwegian goods, paper to the value of 250 million kroner was exported, animal foodstuffs 167 *millions*, fertilisers, chemical products, etc. 76 millions, fats, oils, etc. 46 millions, and timber 76 millions.

During December, 1922, exports of Norwegian goods amounted to 57.5 million kroner, as compared with about 71 and 68 million kroner in November and October respectively.

CHEMICAL TRADE IN BRITISH MALAYA.

In common with other parts of the world, there has been a decided improvement in trade generally in the Malay Peninsula, the improvement being most marked in the latter half of last year. The following statistics dealing with supplies of chemicals, drugs, dyes, etc., for the Malay region clearly indicate this, and should be of interest to manufacturers and export merchants in this country.

The exports go mainly to Siam and the Siamese Malay States, Borneo, French Indo-China, and the Dutch Islands in the Archipelago. Acetic acid is extensively used for the coagulation of latex on the rubber estates of Malaya. In 1921, when the output of rubber was lower and other chemicals were being used, the total import of acetic acid amounted to 48,660 gallons, with an export of 24,699 gallons. Last year the import rose to 387,594 gallons, while only 30,964 gallons were exported.

IMPORTATION OF DYESTUFFS.

Dr. Attlee asked the President of the Board of Trade whether there was a scale for licences on the importation of dyestuffs under the Dyestuffs Act; and, if so, was the licence per pound based upon the colour or its quality, or was it purely arbitrary?

Viscount Wolmer replied: Section 2 (7) of the Dyestuffs (Import Regulation) Act, 1920, empowers the Board of Trade to charge in respect of each licence a fee not exceeding five pounds, to provide for the expenses of administration. The fees actually charged are on a sliding scale, based on the value of the consignment to which each licence relates, and range from 2s. 6d. on consignments of a value up to £100, to £5 on consignments exceeding £3,000 in value.

MORPHINE FACTORIES.

Cr. Bridgeman, the Home Secretary, informed Lord Robert Cecil that morphine factories were subject to inspection by the Home Office Inspectors under the Dangerous Drugs Act. Manufacturers were also required to keep detailed records, and make periodical returns, of their purchases

of the raw material, their production of the drug, and their sales, and a licence had to be obtained for each consignment of the drugs which was exported from this country. The Government were doing all that was in their power to check the abuses of the drug traffic, but until full international co-operation had been secured it would be impossible to prevent them altogether.

BIRMINGHAM SECTION OF THE INSTITUTE OF CHEMISTRY.

It has been decided to revive the Birmingham and Midlands Section of the Institute of Chemistry, which lapsed during the war. A provisional committee has been appointed, rules approved and subfitted to the Council of the Institute for confirmation, and the following officers elected:—Chairman, Professor G. T. Morgan, Professor of Chemistry at the University; hon. treasurer, Dr. J. N. Friend, of the Birmingham Technical School; and hon. secretary, Mr. C. A. F. Hastilow.

It is intended to hold meetings of both a social and professional character, and to endeavour to promote co-operation and friendly intercourse between members of the chemist's profession.

Mr. R. B. Pilcher (Registrar of the Institute) addressed a meeting recently of Fellows and Associates of the Institute of Chemistry in Birmingham.

CORRESPONDENCE.

THE AUTHENTICITY OF THE LATIN WORKS OF GEBER.

To the Editor of THE CHEMICAL NEWS.

SIR,—I was very interested in the account given in *The Chemical News* of Mr. Holmyard's lecture on "Arabian Alchemy and Chemistry."

It seems to be a matter of importance that as many of the Arabian alchemical MSS. as possible should be translated. These may add to our knowledge concerning the early history of chemistry, and settle the question as to whether the works attributed to Geber are to be regarded as those of Dschabir or not.

An English authority, Mr. H. S. Redgrove, in his *Alchemy*, p. 42 (second edition), inclines to Berthelot's view, as does also a German authority, Prof. E. O. von Lippmann, and recently, Dr. E. Darmstaedten has published a volume, entitled *Die Alchemie des Geber ubersetzt und erklärt* (Berlin: J. Springer, 1922), in which he also distinguishes between Geber and Dschabir.

Among other points, he adduces that the Latin works are written in an obscure style, which would not have been the case if they were translations.

I regret I was unable to attend Mr. Holmyard's lecture, since it would be interesting to know upon what evidence he bases his conclusions that Berthelot was wrong in supposing these publications of Geber's to be spurious.—I am, yours etc.,

E. E. WHALE, B.Sc., F.C.S.

London, S.W.17.

NOTICES OF BOOKS.

Handbook on Petroleum, by CAPTAIN J. H. THOMSON and SIR BOVERTON REDWOOD. Fourth edition, revised and added to by MAJOR A. COOPER-KEY, C.B. Pp. XIX. + 342. London: Charles Griffin & Co., Ltd., Exeter Street, W.C.2. 1922. 12s. 6d. net.

The ever-increasing demand for petroleum and its products, and the consequent progress in all branches of the industry has necessitated the publication of this fourth revised edition of Thomson and Redwood's standard and comprehensive treatise on the subject.

Since the publication of the previous edition, technical science is the poorer by the death of Sir Boverton Redwood, and the present one has been revised and brought up-to-date by Major Cooper-Key. His special knowledge relating to such matters as transport, storage, questions of averting risks and dangers, and the official Acts, Orders and Regulations, is now made available for all in a form suitable for immediate reference.

The chapters originally compiled by Sir Boverton have undergone little alteration.

As the old sources of petroleum oils will

gradually become inadequate to meet modern requirements, considerable skill and enterprise will be required to develop and exploit new fields.

This indispensable volume will continue to render most useful service to those engaged in any phase of the industry with which it deals.

A Method for the Identification of Pure Organic Compounds, by SAMUEL P. MULLIKEN, PH.D. Vol. IV. Pp. VII. + 238. London: Chapman & Hall, 11, Henrietta Street, W.C.2. New York: John Wiley & Sons, Inc. 1922. 30s. net.

The chief portion of Prof. Mulliken's compendium is completed by the appearance of Vol. IV.

This has added fourteen "Orders" to the "*Method*," and has involved the tabulation of 3,900 additional specific characterisations to enable the identification of the more important organic compounds of these *Orders* when encountered in practical work.

Vol. I. of the *Method* provided for compounds of carbon, hydrogen and oxygen only; Vol. II. covered compounds containing nitrogen as well. Vol. III. was special, and contained descriptions of pre-war commercial dyes. Vol. IV. deals with the remaining classes of organic compounds, including halogen and sulphur derivatives, alone and with nitrogen bodies.

The sub-divisions are here extensive since all these elements are able to form wide series of *Orders*.

The rapid multiplication of known and applied organic substances and the introduction of better methods of classification necessitates careful revision from time to time, and it is anticipated that a supplementary volume will appear at an early date.

Dyes and their application to Textile Fabrics, by A. J. HALL, B.Sc. (LOND.), F.I.C., F.C.S. Pp. 118. London: Sir Isaac Pitman & Sons, Ltd. 1922. 3s. net.

The subject of this little monograph has received the attention of numerous writers during the past few years, but it is questionable whether the non-technical reader can obtain satisfaction from the extensive literature which already exists. The author has, therefore, made an attempt to interest general readers in this important industry, and we think he has succeeded. He has certainly written an excellent little book, in which he gives a delightful bird's-eye view of the whole of the industry devoted to the manufacture of dyestuffs and their application to various textile materials.

The first chapter gives an account of the development of the dye industry as it is to-day, and shows how it originated in the successful manufacture of coal gas from the work of William Murdoch at the commencement of the nineteenth century. It was not until fifty years after this event that Perkin produced the first synthetic dyestuff—Mauverne—by the use of the derivatives of products obtained from the tar productd in the manufacture of coal gas—a bye-product previously considered as practically valueless and always as a nuisance. Perkin's discovery had the immediate effect of directing the energy of chemists in ths direction, so that to-day we have about a thousand differently constituted dyestuffs which are capable of serving the dyes in one way or another.

Chapters two and three are devoted to the nature of dyestuffs and their manufacture. To illustrate the kind of operations which go on inside a factory manufacturing synthetic dyestuffs, the manufacture of methylene blue is described. At the conclusion of this description the author draws the attention of the reader to the fact that, from his description of the difficulties which have to be solved before a single dyestuff can be manufactured, there is no cause for complaint against those who are endeavouring to establish a dye industry in this country when it is realised that over a thousand dyes have to be manufactured before dyers consider that they have an adequate range of colours.

Chapters four to ten are devoted to a description of the properties of the various textile fibres and the treatments to which they have to be submitted in order that they may acquire the pleasing effects which we have become accustomed to expect in the present-day manufactured textile fabrics.

In conclusion, this book contains numer-

ous excellent illustrations of the type of plant used in the industry. It is also provided with an index

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The "Rapid" Decimal Calculator and Universal Reckoner, by J. GALL INGLIS, F.R.S.E. London: Gall & Inglis, 31, Henrietta St., W.C.2. 1923. 1s. 6d. net.

Since a system of decimal coinage does not yet exist, it may be thought rather premature to publish a Rapid Decimal Calculator. But the publishers seem to view the matter with equanimity, and plunge into issuing a book of 80,000 calculations.

A glance at the leaflet accompanying the book indicates that it is neither more nor less than a gigantic multiplication table, with every unit up to 100 times 150; and the largest figure 504 times 1,050. The publishers also point out that foreign money exchanges, percentages, and even petrol consumption in miles per gallon can be easily found: while the multiplication table in itself will save calculating in square or cubic measures. This is the 77th reckoner issued by this firm.

Cements and Artificial Stones, by the late JOHN WATSON, HON. M.A., F.G.S. Edited by R. H. RASTALL, Sc.D., M.INST.M.M. Pp. XII. + 131. Cambridge, W. Heffer & Sons, Ltd. 1922. 6s. net.

The MSS. dealing with the specimens in the Sedgwick Museum, Cambridge, illustrating the economic geology of building materials, left by the late Mr. Watson, have now been published under the above title.

The volume is, however, more than a museum catalogue, but is not a textbook, since the author does not go deeply into the chemistry and physics of cement-making.

The historical development of this process is most interesting, and valuable information has been included by this method of treatment.

In the descriptive sections, specimens to illustrate the raw materials, intermediate substances and finished cements and artificial stone. The specimens in the collection represent exclusively cements made in the British Isles. Acknowledgment is made to those firms who have contributed to the collection.

It is noticeable that most attention is now given to Portland cements, which are here described in greater detail. Others, including Roman and Sirapite cements, and Plaster of Paris, are also briefly described.

The bibliography at the end, and index, leave little to be desired.

The book certainly deserves the attention of economic Geologists, Architects, Chemical and other Engineers, and others concerned with the manufacture and uses of cement.

H.M. Department of Scientific and Industrial Research has just issued a Second Report upon investigations conducted at the British Museum, entitled *The Cleaning and Restoration of Museum Exhibits*. Price 2s.

The continuation of Dr. Scott's researches has shown the urgent need for investigations of this kind. It is stated that the first report, issued in 1921, has led to numerous enquiries and requests for advice from museums, collectors, and even interested Continental firms. The latter, of course, fall outside the scope of these enquiries.

Especial importance will now be attached to these investigations in view of the recent discoveries in the tomb of King Tutankhamen.

It is a serious duty to succeeding generations to take adequate steps to preserve all collections of the tangible evidence of past phases in the life of mankind, and the appearance of this report should be widely welcomed.

The methods and reagents described must necessarily be used with care and discretion. Variations should only be introduced by experts possessing sound

scientific knowledge, and only after prior experiments have been made upon valueless objects.

Bulletin No. 8 (January, 1923) of the Bureau of Bio-Technology, has just been issued by Messrs. Murphy & Son, Ltd., thus completing the first volume, in which a number of practical contributions to technical biological science have appeared.

The first number of Vol. II. will appear in March, and will contain articles on the *destruction of timber in mills, breweries, and other buildings, and its prevention;* the suppression of insect pests and fungus *diseases in relation to agriculture*, malting, &c., micro-organisms in leather industries; and other matters of industrial importance.

BOOKS RECEIVED.

Vat Colours, by JOCELYN FIELD THORPE, C.B.E., D.Sc., &c., and CHRISTOPHER KELK INGOLD, D.Sc. Pp. XV. + 491. 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 16s. net.

The Rapid Decimal Calculator and Universal Reckoner, by J. GALL INGLIS, F.R.S.E. 1923. Messrs. Gall and Inglis, 20, Bernard Terrace, Edinburgh. 1s. 6d. net.

New Patents.

THIS list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

3348—Coley, H. E.—Manufacture of iron from iron ores. Feb. 5.

3727—Jackson, W. J.—Treatment of copper ores. Feb. 7.

3538—Koppers Co. — Treatment of ammonia-charged gas. Feb. 6.

3488—Plauson Parent Co.—Manufacture of emulsions of oleic acid, etc. Feb. 6.,

3697—Soc. Chimique de la Grande-Paroisse.—Production of a nitrogen-hydrogen mixture for synthetic manufacture of ammonia. Feb. 7.

3476—Sundstrom, C.—Manufacture of a sodium compound. Feb. 6.

Specifications Published this Week.

192106—Marks, E. C. R. (Hoever Co.).—Process of recovering aluminium chloride used in the conversion of high boiling point hydrocarbons into low boiling point hydrocarbons.

192298—Boehringer Sohn, C. H.—Process for the preparation of papaverine nitrite.

192335—Pocock, L. D.—Fertilisers.

181719—Desmond, A., and Another.—Process for making Prussian blue starting from coal gas.

Abstract Published this Week.

190286—Barbituric acid compounds.—Jones, H., of 285, High Holborn, London.

The water-soluble calcium and magnesium salts of C-C-diethyl and C-C-phenylethylbarbituric acids are obtained by digesting a hot saturated solution of the acid with the theoretical quantity of freshly precipitated magnesium carbonate, which has not yet assumed the crystalline state, or of calcium or magnesium hydroxide, *filtering the solution obtained and concentrating* and drying in vacuo at as low a temperature as possible. An example shows the treatment with freshly precipitated magnesium hydroxide. It is post free for the official price of 1s. each. stated that the salts thus obtained are easily absorbable, and give permanent mixtures with the earth-alkali salts of acetylsalicylic acid.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on on post free for the official price of 1s. each.

SITUATION WANTED.

ANALYTICAL CHEMISTS (metallurgical preferred).—Gentleman with university training, desirous of experience and specialising, is willing to give his services as Junior Assistant Chemist for nominal consideration. Midlands preferred.—Address, A. L. Hues, 1, Castle Lane,

THE CHEMICAL NEWS,
VOL. CXXVI. No. 3283.

THE PROBLEM OF SUBSTITUTION IN THE BENZENE NUCLEUS AND THE THOMSON-LEWIS-LANGMUIR THEORY OF CO-VALENCE.

By Ronald Fraser and James Ernest Humphries.

The work of the organic chemists who have directed their attention to the problem of substitution in the benzene nucleus falls naturally under two heads: *speculation on the mechanism of substitution* and the study of the directive influence of substituents already present in the nucleus. The present paper deals only with the second part of the problem, though it is realised that the two are probably interdependent, and the possible effect of addition preceding substitution has been kept constantly in view.

Modern theories, as exemplified by the ideas of Lapworth, Fry, Vorländer, Prins, and Flürscheim,* agree in regarding orientation as occasioned by a differentiated condition—polarity or state of strain—of alternate carbon atoms. These theories inevitably bear among themselves a certain formal analogy, and the ideas here developed are no exception. They agree more particularly with those of Lapworth and Fry in possessing an electrical basis. Nothing is postulated, however, as to the constitution of the benzene nucleus, except that it is, of course, regarded as a six-membered ring; and we consider that the state of the molecule after the entry of a substituent and resulting from its presence is the important factor in orientation (*cf.*, Mills, *J. Soc. Chem. Ind.*, 1921, XL., 417, R., in his review of Fry's monograph).

* *The following references may be given to the papers of these authors: Lapworth, Mem. Man. Phil. Soc.*, 1920, LXIV., ii., 1; *T.*, 1922, CXXI., 416; *Fry, The Electronic Conception of Valence and the Constitution of Benzene*, 1921; *Vorländer, Ber.*, 1919, LII. (B), 263; *Prins. Chem. Weekblad*, 1918, XV., 571; *Flürscheim, J. pr. Chem.*, 1902, LXVI., 321; *ibid.*, 1905, LXXI., 497.

We have taken as our basis the Thomson-Lewis-Langmuir *theory of co-valence*, and on this foundation have built up an electronic interpretation of Lapworth's Principle of Induced Alternate Polarities, as already elaborated by Kermack and Robinson (*T.*, 1922, CXXI., 427). We are not prepared at the present stage to differentiate between the relative sizes of the octets *surrounding positive and negative* centres, and for our present purpose this appears to be of secondary importance. The development of the theory is based on the following three postulates. In order to avoid the introduction of unnecessary synonyms, we shall adopt in the sequel the terminology used by Kermack and Robinson (*loc. cit.*).

Postulate 1: The tendency of a disintegrated octet is towards further disruption; and of a nearly completed octet towards completion.

Postulate 2: The tendency towards octet stability of an atom with nearly completed octet is greater than the tendency to octet instability of an atom with disruption only incipient.

Postulate 3: The more nearly a group *approaches octet stability*, the greater the ease of replacement at that point.

It will be observed that Postulate 2 is simply a statement in terms of octets of the conclusion arrived at by Briggs (*T.*, 1908, XCIII., 1564; *ibid.*, 1917, CXI., 253; *ibid.*, 1919, CXV., 278), viz., that negative fields are in general stronger than positive gelds. Further, the relation of the carbon atom to Postulate 2 is of importance. It is generally recognised that *carbon is unique in that it occupies* the middle position in the first series of the periodic system, and is the first member of its group, containing the fewest number of electrons. It follows, then, that in a chain of carbon atoms of alternately positive and negative character, the positive centres tend to increasing negative character. Some *interesting consequences of this* element's electrical individuality will appear in the sequel.

Postulate 3 requires further discussion. We are of opinion that the distinction between polar and non-polar compounds is merely one of degree, and our views in this respect are those of Briggs (*T.*, 1921, CXIX., 1879), and of Kermack and Robinson (*loc. cit.*). The extreme case of octet stability is evinced in compounds which have come to be known as polar, where an

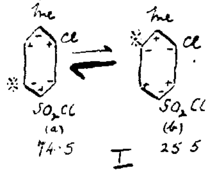
atom surrounded by a completed octet can actually exist free as an ion (*e.g.*, sodium chloride). There are evidently all gradations of octet stability from such extreme cases to those of typically non-polar compounds such as carbon dioxide, where octet stability is *apparently only possible* so long as there is electron-sharing among the octets. It is practically a universal rule that the reactivity of compounds, as measured by the velocity of reaction, is greater in the case of ionised than of non-ionised bodies, although some doubt is thrown on the complete generality of this statement by the work of Kahlenberg (*J. Phys. Chem.*, 1902, VI., 1; and subsequent papers. Compare, however, Stieglitz's discussion of Kahlenburg's results, *Qualitative Chemical Analysis*, Part I., 1912, pp. 84-87). Thus, although we do not anticipate ionisation as a cause of the reactivity of a substituent possessing a stable octet, we do, as a result of the consideration of the above gradation in reactivity, regard increasing octet stability *as parallel with increasing likelihood of* lability.

The Brown and Gibson Rule.

Of the many empirical rules which have been from time to time proposed to summarise the directive influence of substituents on an entering group, undoubtedly the best known is that of Brown and Gibson (T., 1892, LXI., 367). It was unfortunate that Brown and Gibson based at least part of their rule on the lack of knowledge of certain reactions (*cf.*, Hollemann, *Bull. Soc. Chim.*, 1911, IV., series 9, 1-14). Brown and Gibson based their rule on the oxidisability or otherwise of the compound HX, where X is the substituent, whereas the real basis of the rule is rather the tendency to oxidation or reduction of the substituent itself. On the electronic theory of oxidation and reduction, oxidation means loss of electrons, reduction gain of electrons. The ortho-para directive substituents listed by Brown and Gibson have in each case the atom which is linked to the nucleus in a state approaching octet stability, hence loss of electrons (*i.e.*, oxidation) is resisted (Postulate 1); while in the case of the meta-directive substituents, viz., NO_2, COOH, SO_3H, $COCH_3$, the octets of N, C, S, C, are in a state of incipient disruption due to the effect of the negative (octet stable) O, $\therefore\begin{matrix}O\\O\end{matrix}$, O_3, OCH_3 respectively (*cf.*, Kermack and Robinson, *loc. cit.*): hence loss of electrons (*i.e.*, oxidation) is favoured (Postulate 1).*

In short, *negative (octet stable) substituents direct ortho-para; positive (octet unstable) substituents meta.*†

From the above argument the state of polarity of the carbon atoms in a mono-substituted benzene compound containing (1) an ortho-para directive substituent X (Fig. I., a), and (2) a meta directive substituent Y (Fig. I., b) readily follows. In



I

* CCl_3 *is listed by Brown and Gibson among the ortho-para directive substituents, by Vorländer (loc. cit.) among the meta-directive substituents. Spreckels* (*Ber.*, 1919, LII., B, 315) *has obtained the meta nitro compound under conditions which preclude hydrolysis. This is in complete agreement with the octet view, for the carbon atom in* CCl_3, *being attached to three negative (octet-stable) chlorines, is a positive centre, and hence falls into the meta-directive class. Cf., also below.*

It is convenient to note here the meta-directive nature of the ammonium salt group, as investigated by Vorländer and Siebert (*Ber.*, 1919, LII. [B], 283). *On nitrating* $C_6H_5N(CH_3)_3NO_3$, *for instance, the meta compound is obtained. It is evident that the condition of octet stability in* $C_6H_5\overset{+}{N}(\overset{-}{CH_3})_3\overset{+-}{NO_3}$ *is as shown, the signs + and − indicating polarity as resulting from octet instability and octet stability respectively; the N atom attached to the nucleus being a positive centre, the whole group would be expected to direct meta.*

We might mention here that some of the ortho-para directive substituents, comprised of a side chain (Vorländer, loc. cit.), present a difficulty inasmuch as the induced polarity of the nucleus would appear to differ from case to case, as, for example, in $\cdot CH_2COOH$, $\cdot CH_2\cdot CH_2\cdot COOH$, $\cdot CH.CH\cdot COOH$, *all these groups, however, being ortho-para directive.*

Fig. I., a, the octet of X tends to completion; hence the electrons shared with C_1 are drawn into X, making C_1 positive; C_2 can now appropriate electrons shared with the unstable system C_1, acquiring negative polarity; C_3 assumes positive polarity, and so on. † In Fig. I., b, *containing* Y *in a* state of incipient disruption, the polarities are obviously as shown (*cf.*, Lapworth, *Mem. Man. Phil. Soc.*, 1920, LXIV., ii, 1).

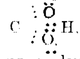
A consideration of the figures will show that whatever is the cause of ortho-para substitution in Fig. I., a, will cause meta substitution in Fig. I., b. The elucidation of these causes involves a special consideration of the position of hydrogen with regard to octet stability. We regard the condition corresponding to octet stability of hydrogen as represented by the nucleus with no electrons.* On this view, the hydrogen atom should be almost entirely lacking in a tendency to acquire an electron, and become the negative hydrogen postulated by Fry (*op. cit.*, pp. 20-27, p. 50). Our views receive strong support from the arguments of Stieglitz (*J. Amer. Chem. Soc.*, 1922, XLIV., 1293) against the existence of negative hydrogen in benzene compounds.

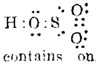
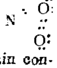
The main consideration seems to be rather the state of the carbon atom to which the hydrogen is attached. In a carbon atom of negative polarity, the octet is comparatively firmly held; hence the hydrogen attached to it is to a great extent deprived of its electron; the converse holding with a carbon atom of positive polarity. Bearing in mind the unique position of hydrogen with regard to octet stability, it is evident that the hydrogen nuclei attached to negative carbon atoms are in a condition for ready substitution (Postulate 3).

Thus it is evident (Fig. I.) that the ortho-para hydrogens in Fig. I., a, are in a condition for ready substitution, while in (b) it is the meta hydrogens which are the more easily replaced. It is seen that the essential difference between the two types of substitution is brought out with exceptional clearness on this view; and, further, the ortho-para directive influence of X on the one hand, and the meta-directive influence of Y on the other, is as it should be, independent of the nature of the entering group.

The special reactivity of the hydrogen *in the para-position to an ortho-para directive substituent follows immediately from the above considerations, inasmuch as* (Fig. I., a), there is a reinforcing negative *influence on the polarity of the 4-carbon* atom.

ENTRY OF POSITIVE GROUPS.

It is well known that most of the radicles which can be introduced directly (*i.e.*, without the action of catalysts), into the benzene nucleus are positive (octet unstable). This follows at once from the preceding considerations. We have computed the number of electrons present in the typical positive radicles, COOH, SO_3H, and NO_2, with the following results: (1) COOH, charge + 1, has sixteen electrons available for the formation of octets; adopting the Hantzsch-Lapworth structure for carboxyl, it is found that the carbon atom contains only six electrons in the sheath, thus:  If the group replace a hydrogen nucleus, the carboxyl carbon can readily complete its octet by sharing with the negative (octet stable) carbon atom in the nucleus, the octet of this atom being left complete by the removal of the hydrogen nucleus. (2) SO_3H. In sulphonation H_2SO_4 reacts as OH − and SO_3H +; on this basis, the SO_3H radicle contains twenty-four electrons available for octet formation.

This leads to the structure  in which the sulphur atom contains only six electrons in the sheath. (3) NO_2. In nitration, HNO_3 reacts as OH − and NO_2; on this basis the number of electrons in the NO_2 radicle available for octet formation is eighteen; this leads to the structure  in which *the unstable centre*, N, *again* con-

† *Attention should be directed at this point to the use of the terms positive and negative applied to the groups mentioned, in view of the fact that in discussions on orientation the terms are used, arbitrarily and in general, with the opposite meaning. This has already been noticed by Davies (T., 1922, CXXI., footnote to p. 786). The same writer (T., 1922, CXXI., 809) disproves the statement made by one of us (Fraser, T., 1922, CXXI., 195) that the directive influence of substituents was partly dependent on their volume. The statement above is now preferred.*

* *These remarks bring hydrogen (and the metals) into line with Postulate 2, which was stated in such a form as to make more obvious its application to the common organic elements, which lie to the right of the Periodic Table.*

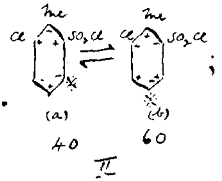
tains six electrons in the sheath. Similar arguments regarding the replacement of *hydrogen apply to cases (2) and (3) as hold* in (1).

It is clear that a negative (octet stable) substituent will not possess an electron content *able to give the easy attainment of* octet formation such as is possible in the cases cited above for positive substituents, and hence we should not expect the nega*tive class to be so readily susceptible to* direct introduction into the nucleus.

It is possible that we have here an underlying reason for the greater stability of *compounds of the type (b) (see Fig. I. in* last week's issue) than those of type (a) (*Cf.* Vorlander, *loc. cit.*).

THE HOLLEMANN SERIES.

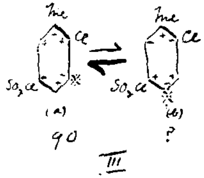
The *relation between octet stability* and directive influence can now be discussed. Consider a typical case of a di-substituted derivative, C_6H_4XY, where the octet stability of X is greater than that of Y.



It follows from the relative stabilities of the octets of X and Y that the polarities of the carbon atoms should be as illustrated in Fig. II (a) rather than that shown in II. (b). Generalising, it can be stated that the relative directive power of substituents follows a descending order of octet stability, and this seems to us to be the real implication of the Hollemann series.

Hollemann (*Die direkte Einfuhrung von Substituenten in den Benzolkern*, 1910, 466-469) points out that the directive tendencies of the commoner substituents follow the descending order: OH, NH_2, Cl, I, Br, CH_3, COOH, SO_3H, NO_2. The tendency to octet stability doubtless follows the descending order: O>N>C (*cf.* Briggs, *Phil. Mag.*, 1921, vi., XLII., 449-450); this accounts for the position of OH, NH_2, CH_3, it being remembered that the kernel octets are attached to positive hydrogen nuclei. The greater volumes of Cl, Br, I, agree with their comparatively low place in the series, increase in electropositiveness with increase in volume being a well established tendency which is readily interpreted electrically.* (One would expect fluorine to be above hydroxyl in the series; next issue.) That all ortho-para directive substituents precede the meta follows from Postulate 2. Considering the meta-directive substituents among themselves, it is evident that electrons are more easily drawn from the labile carbon atom than from the more electropositive sulphur. The larger volume of sulphur as compared with nitrogen agrees with its high position, the effect of electropositiveness being here opposite to that obtaining in the ortho-para directive series.

All possible cases of the entry of the third group into a disubstituted derivative will now be considered.



In the disubstituted compounds represented above, X_1 and X_2 are ortho-para directive (octet stable) substituents; Y_1 and Y_2 are meta directive (octet unstable) substituents.

Case 1: Fig. III., i. The induced polarities of the carbon atoms is as shown in (a) and (b), according as the influence of X_1 or X_2 predominates. Since the inductive effects are opposed, there will be an equilibrium between the two electromers, as indicated above.

The electromer present in greater concentration—a factor evidently determined by the relative octet stabilities of X_1 and X_2—will *react with greater velocity with* the entering group; and the resulting trisubstituted compound will predominate in

* *The position of iodine relative to chlorine and bromine offers a curious anomaly. Owing to the differences of opinion existing with regard to the arrangement of electrons in the heavier atoms (Bohr,* NATURE, *1921,* CVII., 104; *Bury, J.A.C.S.,* 1921, XLIII., 1602), *we have not attempted to account for it.*

the final products. If X_1 has the greater octet stability, further substitution will take place at the 4 and 6 positions; if X_2, at the 3 and 5 positions; *i.e.*, considered from the standpoint of X_1 alone, ortho-para if X_1 is negative and meta if X_1 is positive. If the octet stabilities of X_1 and X_2 are widely different, one electromer may be present in such small concentration that its resultant will not be capable of detection in the final products. On the other hand, if the octet stabilities of X_1 and X_2 are of the same order, the number of products will be greater. The two possibilities may be illustrated by the iodination of o-toluidine (Wheeler and Liddle, *Amer. Chem. J.*, 1909, XLII., 501), and the nitration of o-chlortoluene (Wibaut, *Rec. Trav. Chim.*, 1913, XXXII., 244).

Similar reasoning applies to disubstituted derivatives of the type C_6H_4 $X_1(_1)$ $X_1(_4)$

Case 2, Fig. III., ii. In this case the octet tendencies of X_1 and X_2 reinforce each other, and a single electromer exists. Substitution would be expected to occur at the 4 and 6 positions, which is in agreement with the facts.

Case 3. This is similar to Case 1. If the octet instability of Y_1 is greater than that of Y_2, electromer (a) will predominate, and if conversely, electromer (b). Further substitution will proceed accordingly.

The type C_6H_4 $Y_1(_1)$ $Y_2(_4)$ is similar.

Case 4. A single electromer. Further substitution at 5.

Case 5. A single electromer. The groups X and Y reinforce each other's natural octet tendency. The smooth nitration of the nitrophenols is all in agreement with this statement. The type C_6H_5 $X(_1)$ $Y(_4)$ falls under this case.

Case 6. Equilibrium between electromers holds in this case; reference to Postulate 2 indicates that the direction of equilibrium will be that shown (Fig. III., vi.), and hence ortho-para directive substituents will exert the greater influence in orientation.

The Effect of Conditions.

One of the main difficulties to the formulation of definite rules summarising the facts of orientation is the effect of conditions in altering the relative amounts of the final products of a reaction. On the octet view, this means that the equilibrium pictured above in the electromeric equations, or, in the cases where a single electromer exists, the relative octet stabilities of the substituents, is altered. In either instance, this would indicate that the effect of conditions is largely one of electron transference.

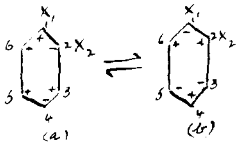
The work of Biltz (*Z. Elek.*, 1911, XVII., 676) has shown that carbon possesses a very high characteristic vibration frequency; and, as stated by W. C. McC. Lewis (*System of Physical Chemistry*, vol. III., 62), "an atom possessing high frequency is no doubt the most likely type of atom to allow of the transference of electrons to and from itself." That electron energy increases with rise of temperature has been indicated by Koenigsberger (*Z. Elek.*, 1911, XVII., 289), and electron lability must also be affected by the nature of the solvent medium (dielectric constant, etc.). It is along these lines that we hope to approach the problem of conditions.

Replacements and Octet Stability.

The term "Replacement" is used to denote the exchange of one substituent for another; "Substitution" refers to the exchange of hydrogen for an entering group. It seems to us that no essential distinction can be drawn between the two processes; and we regard substitution merely as a special case of replacement. No rule of replacement corresponding to a rule of substitution has, so far as we can find, been formulated; but consideration of our remarks on the special case of the "octet stability" of hydrogen appears to lead to some degree of uniformity in this respect. It was pointed out that the lability of hydrogen was conditioned by its tendency to give up its electrons; whereas octet completion is the determining factor in the lability of all other elements attached to the nucleus. In other words, a labile hydrogen is attached to a negative carbon atom, while a labile radicle other than hydrogen is attached to a positive carbon.

Thus, any rule which expresses the facts of substitution will be reversed in the case of replacement; by "reversed" we mean that a group which causes *substitution* in the meta position will favour *replacement* in the ortho-para positions, and conversely. For example, the nitro group causes substitution in the meta position; but in the hydrolysis of the nitranilines, replacement of NH_2 by OH occurs at the ortho-para positions to the nitro group, and not at the meta position. Reasoning on the same lines as

those employed in the discussion of substitution, it will be seen (Fig. IV., a and b),



I

IV

that the octet stability of NH_2 is reinforced by the polarity effects of the nitro group: whereas in Fig. IV. (c). the polar tendencies of NH_2 and NO_2 are opposed, and the lability of NH_2 consequently diminished.† We have found the above rule (which is, of course, the obverse of the Brown and Gibson rule) to be of general application to the simpler cases.

Another interesting rule follows from the unique electrical character of the carbon atom discussed above, if we enquire how the tendency there mentioned towards increasing differentiation of polarity in a chain of carbon

* *A ringed group, thus* (x), *is used here to denote lability following on octet stability.*

† *Reference to Case VI. shows that m-nitraniline exists as two electromers, the* NH_2 *group exerting the greater directive influence. It would appear that the lability of a group is more easily influenced by one of opposite polar tendency than is its directive influence; and this is in general agreement with our views on reactivity. In this connection it should be noted that the* NH_2 *group in aniline itself, while exerting full directive power, requires the reinforcement of ortho or para nitro groups to render it labile in hydrolysis: and many other similar instances could be cited.*

atoms can be satisfied.§ The inductive effect of a substituent on the carbon atoms of the nucleus is greater the greater its octet stability (*cf.* discussion of the Hollemann Series); hence the differentiation of polarity of the carbon *atoms will be increased* by the replacement of the given substituent by a group of greater octet stability. The rule may therefore be stated thus; in replacements, *the entering group is one of greater octet stability than the group replaced.* The hydrolysis of the nitranilines is a case in point, and many others have been examined, and the *rule found to hold.**

A striking example of the application of *the rule is seen in the recent work of* Swarts (*Bull. Acad. roy. Belg.*, 1920, 389) on the nature of the CF_3 group. CF_3 is, as one would expect, meta directive. Unlike $C_6H_5CCl_3$, $C_6H_5CF_3$ can be nitrated under ordinary conditions without hydrolysis of the CF_3 group. This is pre-be looked for, replacement of F by OH is, according to the rule, difficult or impossible.

Hitherto the application of the rule has been confined to the entry of groups of an essentially electronegative character; but we have found that the important class of reduction reactions, where a group is replaced by hydrogen, falls equally under the rule. In a recent series of papers, Mac-

§ *The rules of Michael and Markownikoff may be a consequence of this property of a chain of carbon atoms, the inductive effects being more pronounced when the chain is unsaturated (Kermack and Robinson, loc. cit., pp. 430-432). In the examples* $CH_2CH:COOH + HBr = BrCH_2.CH_2.COOH$; *and* $CH_3.CBr:CH_2 + HBr = CH_3.CBr_2.CH_3$, *the reaction has taken place which increases the polarity (positive or negative) of the carbon atoms.*

* *An apparent exception to the rule is the action of* PCl_5 *on phenols, where OH is replaced by Cl. The chlorines in* PCl_5, *however, may be in an exceptional state of octet stability (cf. Thomson, Phil. Mag., 1921, [vi.], XLI., 521). It is in agreement with the deductions on p. 16 that the reaction takes place more readily with p-nitrophenol than with phenol itself.*

cisely what we should expect on the octet view. It was pointed out (see last week's issue) that fluorine was in all probability more octet stable than any other atom or group: therefore, while the replacement of Cl by the more octet stable OH group is to

beth and his co-workers (Henderson and Macbeth, *T.*, 1922. CXXI., 892; Hirst and Macbeth, *ibid.*, p. 904; Macbeth, *ibid.*, p. 1116) have pointed out that, different as are the structures of compounds with halogens labile towards reducing agents, they have in common the possession of halogen with a strong induced positive polarity—that is, on our view, octet unstable. The octet instability in the cases cited by these authors appears to be unusually pronounced, and hence their ready replacement by negative (octet stable) groups is not to be expected. Their replacement by hydrogen, however, which tends to become electropositive and "octet stable" at the same time (*vide supra*), is in agreement with the rule and with its underlying foundation, viz., *the tendency towards increasing differentiation of polarity of the carbon atoms.* The replacement of the halogen by

It is important to note here the finding of Burton and Kenner (*T.*, 1922, CXXI., 675), that in the removal of halogen in the reduction of halogenated nitro-compounds, the reduction of the nitro groups to amino groups in all probability precedes the removal of the halogen (*cf.* the examples cited by Burton and Kenner, *loc. cit.*, and the papers of Macbeth and his co-workers mentioned above). The present theory would predict that such is the course of these reactions.

EFFECT OF GROUPS ON EACH OTHERS REACTIVITY.

We can now refer more particularly to the loosening or tightening effects on substituents caused by other groups present in the nucleus, as has been referred to already in the simpler cases (Fig. IV.). Among the numerous examples examined, may be cited the following: the loosening effect of meta directive groups on substituents in the ortho-para positions (Schopf and his collaborators, *Ber.*, 1889, XXII., 900, *et seq.*; Kenner, *loc. cit.*); the loosening of ortho-para directive groups on substituents in the meta position (Kenner and Parkin, *T.*, 1920, CXVII., 855; Hollemann and metals in this class of compound (Henderson and Macbeth, *loc. cit.* p. 895) is a similar example of the rule.*

* *The activity or inertness of halogen in the compounds cited by Kenner (T., 1914. CV., 2719) and explained by him on Flürscheim's formulation, can be equally well interpreted, along the above lines; on our views.*

Hollander, *Rec. trav. chim.*, 1920, XXXIX., 435; Guia, *Gazzetta*, 1921, LI., i., 307; Burton and Kenner, *T.*, 1922, CXXI., 489); the tightening effect of ortho-para directive groups on bromine in the para position (Meyer, *Ber.*, 1921, LIV., [B], 2265). An examination of these will show that our views, and in particular Postulate 3, are capable of predicting the observed facts.

THE DIRECTING GROUP IN POLYSUBSTITUTED COMPOUNDS.

In a large number of cases examined by Robinson (Perkin and Robinson, *T.*, 1914, CV., 2379; Jones and Robinson, *T.*, 1917, CXI., 906; Gibson, Simonsen, and Rau, *T.*, 1917, CXI., 73), it is found that when a negative group is in the ortho-para position to a positive group, they neutralise each other, and the orientating effect is exercised by the second positive group. The work of Davies on the cumulative effect of the chlorine atom and the methyl and sulphonyl chloride groups on substitution (Davies, *T.*, 1921, CXIX., 853-876; *ibid.*, 1922, CXXI., 785) affords interesting examples of the applicability and otherwise of the Robinson rule.

In attempting to determine the position taken up by a fourth substituent in a trisubstituted derivative, two main considerations are of importance, viz., the relative octet stabilities of substituents already present, and the persistence of their inductive effects through a chain of carbon atoms.

II

V

Percentage yield of corresponding nitro compounds (substitution at asterisk).

The substances on which Davies worked

(Fig. V.) contain in each case CH_3 and Cl in the ortho relation, the SO_2Cl occupying various positions relative to them. The octet stability of Cl being greater than that of CH_3, the predominating polar state of the molecule, in the absence of the SO_2Cl group would be as indicated in Fig. V., ia, iia, iiia. Consider now the question of the persistence of induction. In Fig. 5 i., the inductive tendency of Cl in reversing the natural polarity of SO_2Cl is greater than that of CH_3, which has the opposite tendency, owing to the difference in the number of carbon atoms through which induction has to be effected. On the other hand, in *Fig. 5 ii., the greater inductive power of* Cl as compared with CH_3 is balanced by *the weakening effect of the carbon atoms* intervening between Cl and SO_2Cl.* In Fig. 5 iii., the SO_2Cl *and Cl have the same* polar effects on the nuclear atoms. The electromeric equilibria in the three cases will therefore be as shown in that figure, and the yields of the nitration products are in agreement. Thus it will be seen that the present theory is borne out by the above experiments; whereas the Robinson rule fails in the third example (*v.*, Davies, *T.*, 1922, CXXI., 786; but *compare* footnote to same page).

The results of Gibson, Simonsen, and Rau (*T.*, 1917, CXI., 69) on the nitration of 2-acetylamino-3-4-dimethoxybenzoic acid and of 3-acetylamino-veratrole, and of Simonsen and Rau (*T.*, 1917 CXI., 220) on the nitration of isomeric acetylamino methoxybenzoic acids, are difficult of interpretation on the octet view, partly owing to the large number of substituents, and hence the difficulty of determining their mutual interdependence; and partly to the difficulty at *the present stage of dogmatising* with regard to the relative octet stabilities of NHAc and OMe.

In the above, we have attempted, on the basis of the Thomson-Lewis-Langmuir theory of co-valence, to connect various theories and rules which at first sight may seem wide apart; to give as consistent a basis as we could to certain observed regularities; and further, to formulate generalisations which may be of use in classifying, and perhaps in predicting the course of, substitution reactions.

Chemistry Department,
University of Aberdeen.

* *Morgan and Jones* (*T.*, 1921, CXIX., 187) *on nitrating 2-chloro 6-nitrotoluene, obtained* 90 *per cent. of the compound corresponding to* iia *above, and* 5-10 *per cent. of* iib. *Reference to remarks on the order of the meta directive substituents indicates that electromer* (*a*) *can exist in greater concentration when an* NO_2 *group is in place of* SO_2Cl.

GENERAL MEETING OF THE CO-OPERATORS IN THE BRITISH CHEMICAL STANDARDS' MOVEMENT.

(Standard Analysed Samples of Iron, Steel, Etc.)

On February 9, at York, a "Report on the Second Three Years' Working" (ending Sept. 30th, 1922) was read, and details of the work during this period were given. A list was given of 53 analysts who had taken part in the standardisation, and 20 firms, who had provided material. Ten new samples comprising 46 actual standards were described. Reference was made to the outstanding events since the commencement, and a chronological list of standards—including the total weights standardised—was shown; and copies of the 32 certificates issued (from the earliest onwards). British, French, and Italian price lists, and diagrams illustrating the preparation of the standards, were exhibited. The extreme precautions taken to ensure perfect homogeneity were described. No allegation as to, or evidence of, lack of homogeneity of the standards was elicited. In view of their wide adoption, every means was used to meet even theoretical difficulties, to warrant the confidence of users.

A sample of shavings of the latest standard, "C," was shown, illustrating their extreme thinness and suitability for direct combustion carbon determination. A single portion of usual weight averaged 1,700 pieces with 90 sq. ins. superficial area.

Within six years the movement had steadily developed and become consolidated, maintaining its progress, in spite of the many adverse conditions of recent years. Commencing with a few co-operators in a few localities, their number and range of interests had multiplied many

times, and now included members from several countries, some 15 to 20 co-operators taking part in each standardisation. The 23 samples produced, comprising 83 standardised results, had covered practically the whole range of plain carbon steels in regular use, and included four alloy steels as well as two cast irons and a basic slag. The weight per standard had risen to twenty or twenty-five times, and the available duration, permanency, and value for reference, had increased proportionately; yet the quality, homogeneity, and fine state of turnings, etc., had not merely been maintained, but improved. Many large works' laboratories used these standards, and their use had so spread that sole agents had been appointed in Italy and France. The 450 British and foreign users included 10 Government Departments, 30 universities and technical schools, and 5 railways.

This progress had fully justified the policy adopted; the organisers, whilst having had the advice and general guidance of the co-operators, had also freedom of *action in detail.*

The organisation was not restricted to any one society or industry, and was not dependent on the same group for standards for which it might not be fitted. For each type, co-operators recognised as experienced specialists in that class of analysis were selected.

Their work had demonstrated that in analysis *divergencies occurred to an unrealised degree* on every sample tested, even under the most favourable conditions of homogeneity and careful working.

Jointly standardised samples were a *necessity* to reveal these divergencies and clear them up.

The rapid development of their movement and consequent *creation of such standardised samples for certain types of material* was the *surest way* to *analytical co-ordination*—which desideratum not only vitally affected the value and status of chemists, but *gave the maker a definite gauge* by which to attune his manufacture, *secure for the engineer or user closer adherence* to *specification,* and *save many delays in delivery,* and *disputes* which now occurred.

Their organisation provided *practical working machinery for* the production and distribution of standards, and they were justified in believing that the same methods used for iron and steel standards could be applied with equal efficiency to *other materials.*

A thorough and interesting discussion followed.

A series of iron and steel standards now existed, which covered the needs of engineers, users, and makers fairly completely, and it was now for these to make **full use of them,** so that the movement's objects could be achieved. Co-operators had offered to arrange meetings to explain the objects of the movement and uses of the standards. Anyone interested could be invited.

Resolutions were passed: (1) Approving *of the general conduct of affairs* by the organisers and adopting their report; (2) thanking the Committee for their assistance in the past and reappointing them *with two others, to act in all matters* where it might not be considered necessary to consult the whole body.

(3) "That we, as co-operators in the British Chemical Standards' Movement, recommend that the fullest use should be made of standard analysed samples of *steel, iron,* and other substances, *particularly* in the following ways:—

(a) By *engineers,* in their chemical specifications, referring regularly to some *specific* standard sample *of similar type,* and requiring that in cases of dispute, a check analysis of it shall be made concurrently by the reference *chemist, as a gauge of the values found.*

(*b*) By *chemists* (*a*) using them periodically for checking and co-ordinating their *routine tests, and* (*b*) *invariably* as an aid to settling disputes, (*c*) stating on their reports that such standards have been used."

"We would recommend *any suitable standards, prepared on a sufficiently wide basis, for acceptance by those between whom disputes may arise, and obtainable by all parties* (for example)—so far as any or all of them conform to this—those prepared by the United States Bureau of Standards, those prepared jointly by the Iron and Steel Institute and National Physical Laboratory, or our own series of British Chemical Standards which are already in use in about 450 laboratories in Great Britain, the Colonies, and other countries;

"And further, we *recommend that* a copy of this resolution be sent to engineering and chemical societies, and that they be earnestly requested to consider the im-

portance of bringing before their members the scientific and practical value of chemical standards."

The fourth resolution bore on the limits of accuracy of analytical methods.

It was resolved, in view of the importance of figures with which it should be coupled, that the Committee should obtain supplementary data and submit this with the resolution to the whole body of co-operators and to such other persons as they might think desirable.

The fifth resolution appointed a Committee to consider the question of forming on a financial basis a more formal organisation, with separate official headquarters, and to report to the co-operators.

GENERAL NOTES.

AUSTRIA'S FOREIGN TRADE IN 1922.

The Commercial Secretary at Vienna (Mr. O. S. Phillpotts) has forwarded a report on the foreign trade of Austria for 1922.

In 1922 there was a large reduction in the value of the imports, and a still larger increase in that of the exports. Consequently, there is an important diminution in the excessive adverse balance of trade from which this country has suffered since the war.

Exports of wood, magnesite, and manufactured goods generally, showed a large increase. The value amounted to 900 million gold crowns (£35.4 millions), or 86 per cent. of all the exports. There were also important increases in cotton goods, made up clothing, paper and paper goods, rubber goods, wooden goods, cement, and iron and metal goods. The export of machinery declined, and although the quantity of leather and leather goods was greater. Of the imports into Austria, Germany sent 37.7 per cent., Czecho-Slovakia 37.1 per cent., Hungary 6.3 per cent., Poland 5.5 per cent. No other country sent more than 2 per cent. The share of the United Kingdom was only 0.6 per cent., but it does not send to Austria much of the bulky and heavy articles such as fuel and foodstuffs. According to British official statistics, the value of the produce and manufactures from the United Kingdom was £1,308,238. This is considerably less than the figure for 1921, £1,734,000, but is much larger than the British imports into the Succession States, Czecho-Slovakia, Hungary, and Yugoslavia, where the import of British goods declined during the year in about the same proportion.

CALCIUM ARSENATE AND WHITE ARSENIC FOR THE UNITED STATES.

The Commercial Counsellor at Washington reports that certain firms in Savannah are desirous of receiving quotations from United Kingdom firms for the supply of calcium arsenate and white arsenic.

The names and addresses of the firms in question, together with further particulars on the subject, may be obtained by U.K. firms interested upon application to the Department of Overseas Trade, 35, Old Queen Street, S.W.

BARIMAR MOVE TO LARGER PREMISES.

To keep pace with the enormous growth of their scientific welding business, Barimar, Ltd., have moved to larger and more commodious London premises at 14/18, Lamb's Conduit Street, Theobalds Road, London, W.C.1. While Barimar, Ltd., make this move from their old premises with considerable reluctance, they feel that they will be serving the interests of their customers best by operating a larger factory with the offices on the spot, and so speed up delivery of repaired parts and be free to handle a greater volume of work under the best conditions. The Barimar Service Depots at Birmingham, Manchester, Leeds, Newcastle-on-Tyne, Cardiff and Glasgow will continue to repair scored cylinders by their metallurgical (patented) process, and to deal with welding and repair work as hitherto.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, MARCH 8, 1923.

Papers read:—

A. B. WOOD, H. E. BROWNE and C. COCHRANE. *Determination of Velocity of Explosion-Waves in Sea Water. Variation*

of Velocity with Temperature. Communicated by F. E. Smith, F.R.S.

P. M. S. BLACKETT. *The Study of Forked Alpha-ray Tracks.* Communicated by Sir Ernest Rutherford, F.R.S.

The methods described in a former paper were applied to the study of the forked alpha-ray tracks obtained by the Wilson condensation method.

Measurements of the lengths of the tracks of the recoil atoms yielded information concerning the relative ionisation due to different kinds of ionising particles, and of the average charge carried by them.

Special methods were developed for obtaining accurate measurements of the angles between different parts of the tracks. Application of this was made to the determination of the masses of the recoil atoms in three particularly favourable cases. These measurements gave values, within the limits of the probable error, in agreement with those to be expected from the composition of the gas.

A. EGERTON. *On the Vapour Pressure of Lead. I.* Communicated by Prof. F. A. Lindemann, F.R.S.

The vapour pressure of lead is measured by effusion of vapour at low pressure through a hole of measured area. Temperature is maintained constant by a selenium cell relay arrangement within 1/3° C. for many hours at temperature about 800° C. Pressures have been measured to 10^{-5} mm. The vapour pressure of ordinary lead between 1,200-600° absolute is expressed by the equation

$$\log p = 7.908 - \frac{9932}{T}.$$

An attempt has been made to determine the difference of vapour pressure of lead and the uranium-lead isotope; the experiments lead to a difference of 2 per cent., but the result is rendered uncertain by an unexplained lowering of vapour pressure which lead undergoes on prolonged heating *in vacuo*.

A. C. EGERTON and W. B. LEE. *Some Density Determinations.* Communicated by Prof. F. A. Lindemann, F.R.S.

The Archimedes method of determining densities is rendered more accurate by utilising certain mobile and heavy organic liquids which avoid air bubbles and damping difficulties, and increase the weight of liquid displaced. The suspension difficulty is also overcome.

The density and boiling points of the liquids employed—ethylene dibromide and carbon tetrachloride—have been determined with accuracy. Density determinations are discussed and a differential method suggested.

The preparation of a satisfactory sample of metal for density determination is rendered possible by filtering, casting and heating *in vacuo*.

The density of lead is determined, viz., 11.3437 at 20° C. The probable error of the nine determinations on three different samples of metal is 1 part in 100,000. The maximum departure from the mean value for any single determination is less than 1 part in 12,000.

The density of a sample of uranium-lead is checked, and would have an atomic weight of 206.26 from the density obtained.

Determinations of the density of a small sample of cadmium of 1.5 grams weight agree to 1 part in 20,000.

A. C. EGERTON and W. B. LEE. *Separation of Isotopes of Zinc.* Communicated by Prof. F. A. Lindemann, F.R.S.

Two sets of distillations of pure zinc have been carried out in high vacuum, under conditions to obtain a slightly different concentration of the isotopes in the final residue of the final distillate. The conditions under which the samples are prepared for density determinations are described. The samples are cast *in vacuo* and seeded with a particular kind of zinc.

The measurements of density are carried out by the method described in the preceding paper, with improvements to the apparatus.

The first set of distillations gave a residue of slightly increased density, but the distillate possessed the same density as the original zinc. The second set of distillations gave a residue of increased density (about 1 part in 3,700) and a distillate of decreased density (about 1 part in 3,000). Determinations on seven samples of ordinary zinc agree in giving the density of zinc (prepared in the described way) as 7.1400 (the probable error being less than 1 part in 100,000).

Flaws, allotropes, different physical conditions, and impurities as explanations of the result are shown to be improbable. The result lies outside the experimental error.

The amount of the separation agrees with Dempster's observations of isotopes of weights extending over six units (viz.,

34·70), but is not as great as might be found for equal parts of 64 and of atoms of weights 66, 68 and 70.

E. HATSCHEK and P. C. L. THORNE. *Metal Sols in Non-dissociating Liquids. I.—Nickel in Toluene and Benzene.* Communicated by Prof. A. W. Porter, F.R.S.

The results obtained so far may be summarised as follows:—

Very stable sols of nickel in a medium free from ions can be produced by decomposing nickel carbonyl dissolved in mixtures o toluene and benzene, containing a small amount of rubber, at 100° C.

In the electric field the particles of disperse phase move to, and deposit on, *both* electrodes.

Electrophoresis in fields of different strengths, all other factors being equal, shows that the amounts deposited are proportional to the first, or a lower, power of the potential gradient. The charges, therefore, are not induced ones, but positively and negatively charged particles are originally present in the sol.

The sol resembles typical protected aqueous sols, inasmuch as it is coagulated by liquids which are not solvents for the protective colloid, *i.e.*, rubber. The coagulum is only very imperfectly peptized again by rubber solvents, such as toluene or benzene.

Paper read in title only:—

H. HIRATA. *Constitution of the X-ray Spectra belonging to the L Series of the Elements.* Communicated by Sir William Bragg, F.R.S.

THURSDAY, MARCH 15, 1923.

Papers read:—

G. C. STEWARD. *Aberration Diffraction Effects.* Communicated by Prof. A. S. Eddington, F.R.S.

Papers read in title only:—

LORD RAYLEIGH, F.R.S. *Further Observations on the Spectrum of the Night Sky.*

LORD RAYLEIGH, F.R.S. *Studies of ridescent Colour, and the Structure producing it. IV.—Iridescent Beetles.*

PROF. J. W. NICHOLSON, F.R.S. *Oblate Spheroidal Harmonies and their Applications.*

PROF. J. W. NICHOLSON, F.R.S., and PROF. F. J. CHESHIRE. *On the Theory and Testing of Right-angled Prisms.*

PROF. J. C. MCLENNAN, F.R.S. and D. S. AINSLIE. *On the Fluorescence and Channeled Absorption Spectra of Caesium and other Alkali Elements.*

W. STILES, Sc.D. *The Indicator Method for the Determination of Coefficients of Diffusion in Gels, with special reference to the Diffusion of Chlorides.* Communicated by W. B. Hardy, Sec. R.S.

H. T. FLINT. *A Generalised Vector Analysis of Four Dimensions.* Communicated by Prof. O. W. Richardson, F.R.S.

ROYAL INSTITUTION OF GREAT BRITAIN.

On Saturday, March 17, SIR ERNEST RUTHERFORD, LL.D., D.Sc., F.R.S., will give his fifth lecture on *Atomic Projectiles and their Properties*, dealing with the life history of an α-particle from radium.

On March 13, PROF. C. G. SELIGMAN delivered the first of two lectures at the Royal Institution, on *Rainmakers and Divine Kings of the Nile Valley;* and on March 15, COLONEL E. F. STRANGE began a course of two lectures on *Japanese and Chinese Lacquer.*

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, THURSDAY, MARCH 15, 1923.

The following papers were read.—

The oxime of mesoxamide (isonitrosomalonamide) and some allied compounds. Part III.—Ring formation in the tetrasubstituted series. E. H. USHERWOOD and M. A. WHITLEY.

The preparation and stability of cuprous nitrate and other cuprous salts in the presence of nitrites. H. H. MORGAN.

The interaction of hydrogen sulphide, thiocyanogen and thiocyani cacid with unsaturated compounds. F. CHALLENGER, A. L. SMITH, and F. J. PATON.

The polarity of double bonds. T. M. LOWRY.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The Tenth Annual General Meeting was held at the House of The Royal Society of Arts, John Street, Adelphi, on March 13. PROF. J. S. S. BRAME, F.I.C., F.C.S., the retiring President, gave an address.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

At the Ordinary Meeting, held at the Chemical Society's Rooms on March 7, Mr. P. A. Ellis Richards, President, in the chair, certificates were read for the first time in favour of: Mr. John Myers, F.I.C., and John Loudon Buchanan, F.I.C.

Certificates were read for the *second* time in favour of: Messrs. Joseph John V. Baikes, A.R.C.Sc., A.I.C., D.I.C., Samuel Gordon Stevenson, A.I.C., Laurence Barnett Timmis, M.Sc.Tech. (Manch.), A.I.C., Richard William Sutton, B.Sc.-Tech. (Manch.), A.I.C., Alfred Edward Johnson, B.Sc. (Lond.), F.I.C., A.R.C.S.I., Ernest Victor Jones, F.I.C., Francis Kenelm Donovan, S. Gordon Liversedge, F.I.C.

The following were elected members of the Society: Messrs. George Henry Appleyard, F.I.C., Arthur William Starey, A.R.C.S., B.Sc. (Lond.), A.I.C., John Matthew Wilkie, B.Sc. (Lond.), F.I.C.

The following are abstracts of the papers communicated:—

The Examination of Firearms and Projectiles, by A. Lucas, O.B.E., F.I.C.

The scientific methods used for the identification of firearms and projectiles in cases of wounds or deaths from shooting were discussed. It was shown that a particular weapon may sometimes be recognised by the rifling marks imprinted on a bullet, and that the nature of the fouling left in the barrel after the weapon has been fired may also afford valuable information both as to the nature of the original powder and also, in some cases, the period that has elapsed since the last discharge. The composition, dimensions, and markings on bullets, slugs, etc., were described, and directions were given for the reproduction of rifling marks on bullets, and for the chemical analysis of projectiles of all kinds.

The Interpretation of the Results obtained in the Analysis of Potable Waters, by Robert C. Frederick.

This is an account of an extended investigation into the chemical changes which occur in samples of excretally polluted water. The findings are considered in conjunction with the results obtained by the author in the analysis of a very large number of samples from every kind of supply throughout the British Isles. The orthodox ideas in regard to the interpretation of the analytical results of such examinations are criticised and the author's own views detailed.

Determination of the Purity of Vanillin, by Sydney B. Phillips, A.I.C.

After reviewing the various methods proposed from time to time, the author described two processes for estimating vanillin. The first was a volumetric one, where 1 gram of vanillin is dissolved in 20 cc. of neutral alcohol, and acid impurities are neutralised. 1.2 grams of *p*-toludine are then added, and 20 cc. of semi-normal sodium hydroxide solution are measured in, followed by 100 cc. of cold water. The solution at 15° C. is titrated with semi-normal sulphuric acid until the permanent precipitate of the condensation product of vanillin and *p*-toluidine is formed. The difference between the volumes of alkali and acid represents the volume of alkali required to combine with the vanillin.

A summary of the gravimetric method is as follows:—One gram of vanillin is dissolved in 13.6 cc. of semi-normal sodium hydroxide. To this is added a solution of 2.4 grams semi-carbazide hydrochloride and 3 grams of anhydrous sodium acetate, or 5 grams of the crystalline salt in 30 cc. of water. The mixture is heated on a boiling water bath for 10 minutes, allowed to stand in the cold for four hours, and the semi-carbazone filtered off, washed, dried, and weighed. It is treated with ammonium hydroxide solution, and the insoluble portion filtered off, washed, dried, and weighed. This weight is deducted from the original weight of semi-carbazone, and the remainder calculated to vanillin.

MINERALOGICAL SOCIETY.

The following papers were communicated on March 13:—

A. Hutchinson. *A Graphical Method of Correcting Specific Gravity Determinations.*

C. E. Tilley. *Genesis of Rhombic Pyroxene in Thermal Metamorphism. Mineral Associations and the Phase Rule.*

C. S. Garnett. *On a Peculiar Chlorite-rock from Ible, Derbyshire. The Dissociation of Dolomite.*

A. Brammall and H. F. Harwood. *The Dartmoor Granite: (a) Porphyritic Felspars and Biotite, (b) Andalusite, Sillimanite, Cordierite, and Spinellids.*

J. G. C. Leech. *Some occurrences of Titanium Minerals on St. Austell Moor.*

ROYAL SOCIETY OF ARTS.

ARRANGEMENTS FOR MEETINGS DURING MARCH, 1923.

Monday, March 5, 8 p.m. (Canton Lecture). — J. E. SEARS, C.B.E., M.A., M.I.MECH.E., Superintendent of Metrology, National Physical Laboratory, and Deputy Warden of the Standards, *Length Measurement*. (Lecture 1.)

Tuesday, March 6, 4.30 p.m. (Dominions and Colonies Section).—MAJOR E. A. BELCHER, C.B.E., Assistant General Manager, British Empire Exhibition, *The Dominion and Colonial Sections of the British Empire Exhibition*, 1924. The Rt. Hon. L. S. Amery, M.P., will preside.

Wednesday, March 7, 8 p.m. (Ordinary Meeting).—PROF. E. P. STEBBING, M.A., F.L.S., Professor of Forestry, University of Edinburgh, *The Forests of North Russia and their Economic Importance*. The Rt. Hon. Lord Clinton, Forestry Commissioner, will preside.

Monday, March 12, 8 p.m. (Cantor Lecture).—J. E. SEARS, JUN., C.B.E., M.A., M.I.MECH.E., Superintendent of Metrology, National Physical Laboratory, and Deputy Warden of the Standards, *Accurate Length Measurement*. (Lecture 2.)

Wednesday, March 14, 8 p.m. (Ordinary Meeting).—SIR WILLIAM WARRENDER MACKENZIE, K.B.E., K.C., President of the Industrial Court, *Industrial Arbitration*. Lord Askwith, K.C.B., K.C., D.C.L., Vice-Pesident of the Society and Chairman of the Council, will preside.

Friday, March 16, 4.30 p.m. (Dominions and Colonies and Indian Sections).—LT.-COL. SIR LEONARD ROGERS, C.I.E., F.R.S., F.R.C.P., F.R.C.S., Physician and Lecturer, London School of Tropical Medicine, *Recent Advances towards the Solution of the Leprosy Problem*.

Monday, March 19, 8 p.m. (Cantor Lecture).—J. E. SEARS, JUN., C.B.E., M.A., M.I.MECH.E., Superintendent of Metrology, National Physical Laboratory, and Deputy Warden of Standards, *Accurate Length Measurement*. (Lecture 3.)

Wednesday, March 21, 8 p.m. (Ordinary Meeting). — F. W. EDRIDGE-GREEN, C.B.E., M.D., F.R.C.S., *Some Curious Phenomena of Vision and their Practical Importance*. Prof. E. H. Starling, C.M.G., F.R.S., will preside.

On Monday, March 12, J. E. SEARS, JUN., C.B.E., M.A., M.I.M.E., ASSOC.M.-INST.C.E., Superintendent of Metrology Dept., National Physical Laboratory, gave his second Cantor Lecture, entitled *Accurate Length Measurement*.

THE INSTITUTE OF METALS.

At the Annual General Meeting of the Institute of Metals, held in London, on Wednesday, March 7, the following officers were elected to serve for the year 1923-24:

President: Leonard Sumner, O.B.E., M.Sc.

Past-Presidents: Sir Gerard A. Muntz, Bart., Engineer Vice-Admiral Sir Henry J. Oram, K.C.B., F.R.S., Sir George Heilby, Kt., F.R.S., LL.D., Professor H. C. H. Carpenter, M.A., Ph.D., A.R.S.M., F.R.S., Engineer Vice-Admiral Sir George Goodwin, K.C.B., LL.D.

Honorary Treasurer: A. E. Seaton, London.

Sixty new members were elected, bringing the membership total to 1,458. The next election is due to take place on April 19. Particulars can be obtained from the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

NOTICES OF BOOKS.

Theophrastus Bombastus von Hohenheim called Paracelsus, by JOHN MAXSON STILLMAN. Pp. X. + 183. London: The Open Court Publishing Co., 149, Strand, W.C.2. Price 10s.

For almost four centuries the name and fame of Paracelsus have come down to us with something of the legendary haze of fables. Not all that is associated with his name can truly be ascribed to him. Recent investigatons have indicated how greatly his teachings and practices revived a spirit of scientific enquiry in medicine and chemistry.

It is interesting to note that, in conformity with the custom of the times, Hohenheim adopted the Latin name Paracelsus, yet he delivered his discourses at Basel and elsewhere in German.

He was a very zealous, original writer, and distinguished himself by being very critical of the time-honoured ideas and methods of his age. The accusation that he wa[illegible]

he violently opposed all the works and methods of Galen, although these contained much that was true.

It appears that Paracelsus wrote no definitely chemical or alchemical treatises, but in many of his medical and philosophical writings he contributed much to early chemical knowledge. He developed the theory of the three elements—sulphur, mercury, and salt—but his theoretical views were naturally fanciful, and might even be styled unscientific.

However, he made one thing clear, namely, that the transmutation of metals was not the sole aim of alchemy, and that attention could be more profitably directed to the discovery of curative medicaments.

The present biography of Paracelsus is probably the best in existence, dealing as it does in a fair and scientific manner with his stormy and nomadic career, and his influence upon contemporary and later science and medicine. The volume will undoubtedly be widely read by chemists and students interested in the history of their science. J.G.F.D.

Discoveries and Inventions of the Twentieth Century, by EDWARD CRESSY. Second edition. Pp. XXIII. + 453. London: George Routledge & Sons, Ltd. 1922. Price 12s. 6d. net.

The first edition of this excellent book appeared in 1914, and the general scope of the work remains very much the same as previously. As the result of the war we have passed through a period of intense activity in discovery and invention, and therefore considerable alterations have been made to bring all the subjects dealt with previously up to date. In only one instance has no attempt been made to carry out the necessary revision, and in this case Ships of War and their Weapons —the information available was not sufficiently reliable to render such revision possible, and so the chapter has been omitted altogether. In its place a new chapter appears, which endeavours to give an elementary account of some of the achievements of modern chemistry, especially in relation to physics and biology, under the title, "The Borderland of Chemistry."

This chapter is divided into sections, and the subjects dealt with are colloids, the utility of froth, catalysis, fermentation and vitamines. The treatment appears adequate in each case. In the section dealing with colloids we find the following statement: "Many sols are only stable in the presence of an electrolyte." Of course it should read that the absence of electrolytes favours the stability of certain sols. This is an unfortunate error, but readers should easily detect it. Again, when speaking of oleum in the section on catalysis, oleum is given the formula $H_2S_2O_7$, which is incorrect. Actually, oleum is simply a solution of sulphur trioxide in sulphuric acid, and has no fixed composition. In industry, certain more or less standard strengths of oleum are met with, such as 20 per cent. and 60 per cent.—this percentage figure simply referring to the content of sulphur trioxide in the oleum.

Generally speaking, the book is well published, and the illustrations are good, but we have noticed a few minor errors, such as "sodium chlorine" for "sodium chloride" (p. 433), and the spelling of radioactivity on page 442. Such errors are perhaps pardonable, and accordingly we have no hesitation in recommending this book to all those who desire to have a non-technical account of the chief scientific and material triumphs which man has achieved and is achieving at the present time.

BOOKS RECEIVED.

Skinner's Cotton Trade Directory, by THOMAS SKINNER & Co. Pp. CCLVI. + 1,504. 1923. Messrs. Thomas Skinner & Co., Gresham House, E.C.2. 12s. 6d. net.

Back to Prosperity: A New Aspect of Practical Life, by HENRY LOWENFELD and his Daughter, MARGARET LOWENFELD. Pp. 268 + XI. 1923. Effingham Wilson, 16, Copthall Avenue, E.C.2. 5s. net.

The Mathematical Theory of Relativity, by A. S. EDDINGTON. Pp. IX. + 247. 1923. The Cambridge University Press, Fetter Lane, E.C.4. 20s. net.

The U.S. Dept. of the Interior has issued the following bulletins:—

The Inorganic Constituents of Marine Invertebrates, by FRANK WIGGLESWORTH CLARKE and WALTER COLBOURN WHEELER.

Preliminary Report on Fossil Vertebrates of the San Pedro Valley, Arizona, by JAMES W. GIDLEY.

The Shapes of Beach Pebbles, by CHESTER K. WENTWORTH.

Forty-third Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior.

Gold, Silver, Copper and Lead in South Kakota and Wyoming in 1921, by C. W. HENDERSON.

Gold, Silver, Copper, Lead and Zinc in Utah in 1921, by V. C. HEIKES.

Manufactured Gas and By-products in 1920, by R. S. MCBRIDE.

Slectric Brass Furnace Practice, by H. W. GILLETT and E. L. MACK.

Preparation of Light Aluminium Copper Casting Alloys, by R. J. ANDERSON.

Surface Water Supply of the United States, 1918, *Part III.—Ohio River Basin.*

Surface Water Supply of the United States, 1919-1920. *Part VII.—Lower Mississippi River Basin.*

High-Grade Clays of the Eastern United States, by H. RIES, W. S. BAYLEY, and others.

Phytrographic Provinces and Sections in Western Oklahoma and Adjacent •parts of Texas, by NEVIN M. FENNEMAN.

General Features of the Magnetite Ores of Western North Carolina and Eastern Tennessee, by W. S. BAYLEY.

Peridotite Dikes in Scott County, Arkansas, by HUGH D. UNKER and CLARENCE S. ROSS.

Geology of the Ranger Oil Field, Texas, by FRANK REEVES.

The Brooks, Steen and Grand Saline Salt Domes, Smith and Van Zandt Counties, Texas, by SYDNEY POWERS and OLIVER B. HOPKINS.

Chromite of Kenar Peninsula, Alaska, by A. C. GILL.

Geology of the York Tin Deposits, Alaska, by E. STEIDTMANN and S. H. CATHCART.

Natural Gas Manual for the Home.

New Patents

THIS list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

4603—Basset, L. P.—Process for direct reduction of iron, etc., ores. Feb. 16.
4140—Berlin, D. W.—Method of reducing metallic oxides. Feb. 12.
4064—Dutt, E.—Extraction of radio-active constituents from titaniferous materials. Feb. 12.
4065—Dutt, E.—Separation of hafnium from titaniferous materials. Feb. 12.
4619—Jques, A.—Manufacture of ammonium
4619—Jaques, A.—Manufacture of ammonium compounds. Feb. 16.
4509—Maydegger, O.—Process of manufacturing sulphate of chrome. Feb. 15.
4619—West, J. H.—Manufacture of ammonium compounds. Feb. 16.

Specifications Published this Week.

192426—Reid, J. H.—Reduction of ore and the production of gas.
192438—Akt-Ges Fur Anilon-Fabrikation.—Manufacture of new-ortho-oxyazo dyestuffs.

Abstract Published this Week.

191715—Barium Oxide.—Dietrich, W. von, Coswig, Anhalt, Germany.

The manufacture of barium oxide by the action of heat on a mixture of barium carbonate and a reducing agent such as carbon, pitch, tar, or the like, is carried out under reduced pressure in a rotary furnace or a furnace provided with means for agitating the reaction mixture. The furnace is preferably heated internally by electrical means, but heat may be applied instead, or in addition, from the outside. In an example a mixture of 100 kgs. of barium carbonate and 7 kgs. of carbon is heated to 1,000-1,100° C., under a pressure of 65-70 cms. of mercury.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3284.

VALENCY.

By William R. Fielding, M.A., M.Sc. (Vict.).

Senior Science Master, King Edward VII. School, Lytham.

(1) Definition of Valency.

Valency is the capacity which one atom of a substance has of holding, or combining with, *one or more atoms of itself or another* element. It is the means which holds together the bricks out of which chemical compounds are built up.

(2) Hydrogen as the Standard.

The capacity of hydrogen to combine with other elements is taken as the standard. Thus, in

HCl, hydrogen and chlorine are monads;
H_2O, oxygen is a dyad;
H_3N, *nitrogen is a triad;*
H_4C, carbon is a tetrad.

This is the highest valency shown by any element towards hydrogen. In their compounds with hydrogen the halogens are monads (except where association or polymerisation takes place), so that the valency of elements is often deduced from the halides,

e.g., NaCl, $BaCl_2$. PCl_3.

(3) Method of Finding Valency.

The valency of any particular element differs according to the standard-element with which it is compared (hydrogen or halogen), *e.g.*, phosphorus is triad in PH_3 and pentavalent in PCl_5; iodine is monad in ICl and KI, but appears to be triad in ICl_3; nitrogen is a triad in NH_3, but pentad in the easily dissociable compound NH_4Cl; sulphur is dyad in S_2Cl_2, tetrad in SO_2 and SCl_4, and hexad in SO_3 and SF_6.

The simplest method (but it is not always applicable)of finding the valency is to find both the atomic weight and the equivalent of the element in question, when *it is found that the following relationship* holds:

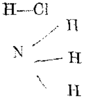
$$\frac{\text{Atomic Weight}}{\text{Equivalent Weight}} = \text{Valency.}$$

If the composition of the compound gives the empirical formula A B the valencies are as y : x, unless the problem is rendered more difficult by the existence of complex linkages which are sometimes difficult to recognise.

(4) Representation of Valency.

Owing to the custom of the last half-century, valencies are represented by straight lines or dots, thus:—

H—Cl H. O. H

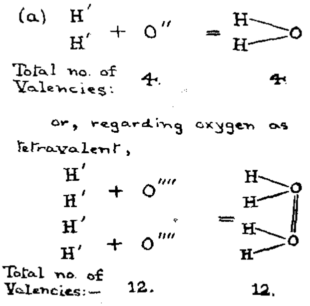


The length and direction of the lines representing valencies, links, bonds, etc., are *matters of no importance; the valencies of* the elements forming a compound do not necessarily act in the *same plane*. A frequent source of error in reckoning the valency of an element is the overlooking of some of its linkages, which may be unused (as in unsaturated compounds), or even doubled or trebled.

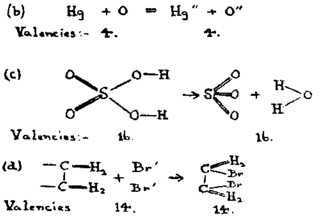
Carbon is tetrad in CH_4 and $C\,Cl_4$; also in $=C=O$; but two valencies are reposing in the latter molecule until they have an opportunity of combining with chlorine or sulphur, to form $COCl_2$ or COS respectively. In C_2H_6 one of the valencies of carbon appears to be absent until we write the formula *graphically, when the position of the* fourth valency is discovered.

(5) Law of the Indestructibility of Valencies.

What may be termed the law of indestructibility of valencies at any temperature may be seen from the following examples (Fig. I.):—



If the whole of the valencies were used up in forming a compound, there would be no association or polymerisation (Fig. 2):—



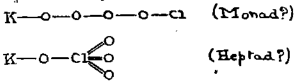
(Fig 2.)

(e) As long as the temperature at the beginning and end of the action is the same the law holds. *E.g.*, the "combining" of hydrogen and oxygen at, say, 8,000° C.

H   H
      O   =   O
H   H

Valencies O   O (no water formed)

Chlorine is a monad in KCl; what is it in $KClO_3$ and $KClO_4$?



(Fig 5.)

The monovalent element, iodine, becomes pentavalent in IF_5. In hydrofluoric acid fluorine is monad at 100° C. (Gore);

H—F

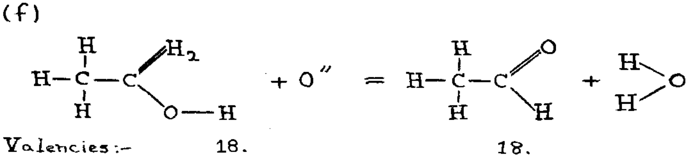
divalent at 30° C. (Mallet);

H—F
|
H—F

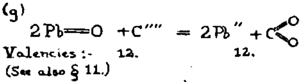
and poly-valent ($H_x F_x$) at lower temperatures. A cryoscopic determination of the molecular weight gives $H_2 F_2$. (Abegg).

Even the valency of the *standard* element appears to alter in triatomic hydrogen!

H —H
\ |
H



(Fig 3.)



(Fig 4.)

(6) Variability of Valencies.

A most perplexing question is the variability of valency

(1) for any particular element,

(2) according to the position of the element in the periodic table (this will be referred to later). *E.g.*, oxygen is dyad in H_2O; is it tetrad in carbon monoxide?

It is as difficult to explain why phosphorus is only trivalent towards hydrogen but pentavalent towards oxygen and chlorine as it is to explain why a person's appetite for one food is so different for another.

(7) Variation of Valency with Temperaeure and Pressure.

Then valency may vary according to changes in temperature and pressure, etc. Phosphorus is trivalent in PH_3, but if a mixture of equal volumes of PH_3 and HCl is subjected to pressure, the two combine to form phosphonium chloride, in which

phosphorus is pentavalent. When the pressure is reduced the valency is reduced, also, from 5 to 3. The same thing happens in the case of NH_3 and HCl, except that the reaction takes place at (our present) "*ordinary temperature and pressure.*"

The changes in valency with changes of temperature are very significant. Representing an atom by a circle, and showing only the interchanged electrons (by dots), we can represent a molecule of, say, NaCl, thus (Fig. VI):—

Na Cl

Fig. VI.

the chlorine drawing an electron from the sodium atom towards it. It may either be included in the outer ring of electrons in the chlorine atom or oscillating between the two atoms. *Both the sodium and* chlorine atoms become ionic, and within each atom there is a readjustment in the orbits of the electrons to meet the new situation. As temperature rises, the NaCl is decomposed, the electronic "link" snapping or ceasing to function. From the practical point of view of formation of compounds, all elements are non-valent towards each other above a certain temperature, as they are below a certain temperature. Even sodium and chlorine which unite with such vigour at ordinary temperatures, will not combine below ; as the temperature falls, polymerisation or association is often increased so that the valency which causes polymerisation is less strong than that required for combination between unlike atoms. We might tabulate the results as follows:—

(1) *At very high temperatures, say, the temperature of the sun*, Sodium and chlorine are non-valent towards each other.

(2) *At ordinary temperature*, Sodium and chlorine are approximately monovalent towards each other, uniting to form NaCl.

(3) *At very low temperatures*, Sodium and chlorine are non-valent towards each other; but molecules of sodium associate *with other molecules* of sodium and molecules of chlorine with other molecules of chlorine. Sodium must be at least divalent, making no distinction at present between primary and secondary valencies.

These facts have more than a passing interest for us because throughout the whole range of temperature through which the universe has passed, or will pass, say, from 20,000° C. to the absolute zero, it is only through a relatively small range of temp. that life in any form is possible. On valency depends the formation of compounds —organic compounds for food, organic compounds present in the make-up of a living organism—all of which are destroyed *when heated over a small range of temperature*. Whatever the genesis of life (as we know it in the material world), unless it gets a foothold during this vital range of temperature, life, either on the earth, or Mars, or other celestial bodies, is impossible.

Many chemical compounds might be mentioned to show that the valency of one *element for another element frequently* varies even within the valency-limits just referred to; *e.g.*, the chlorides of sulphur.

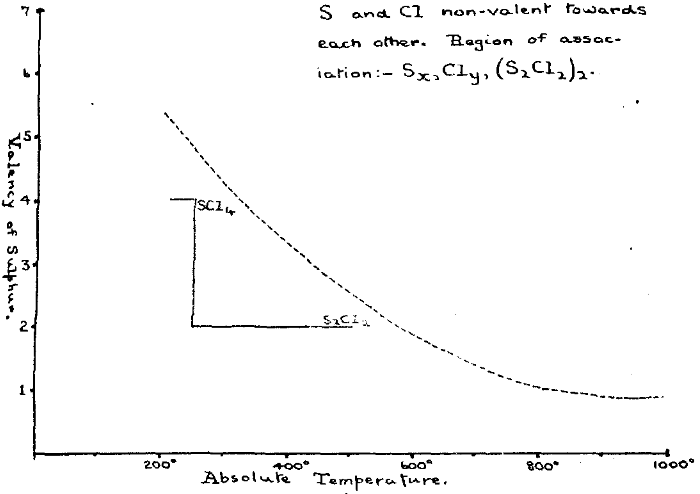
Sulphur Monochloride (S_2Cl_2).

B.p.	138° C.	(411° A)
M.P.	—80° C.	(193° A)

This liquid saturated at 251° A with *chlorine is transformed into* SCl_4 M.P. 242° A. On removing it from the freezing mixture the valency is reduced and $S_2\ Cl_2$ and Cl_2 are again formed. These changes are shown in the diagram (Fig. VII.)

The valency between sulphur and chlorine is shown in steps. At 251° A, thirty-two parts by weight of sulphur can "hold" 142 parts of chlorine; at a higher temp. only 35.5 parts of chlorine. There may be an intermediate point where 32 parts of sulphur are satisfied by 60 or 80 parts of chlorine if there existed a standard substance with which they could be compared: only as union between sulphur and chlorine takes place in atoms and not in fractions of an atom, the compounds of sulphur and chlorine must be

$$S\ Cl\ ,\quad S_2\ Cl_2\ ,\quad \text{etc.}$$



(Fig 7.)

The dotted line shows the possible value of the valency of sulphur for chlorine and accounts for the "residual" valency which is used to account for the formation of polymers, complex atoms, etc.

Water might be quoted as another example. At high temperatures it is dissociated into hydrogen and oxygen (when they become non-valent towards each other); between 0° and 100° C. not only is H_2O present, but varying amounts of $(H_2O)_2$, and $(H_2O)_3$. The formation of the latter postulate a higher valency for either hydrogen or oxygen, or both.

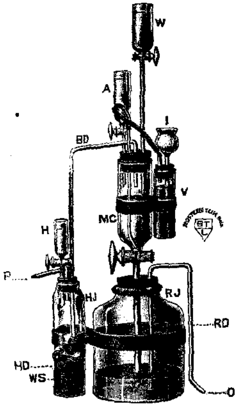
(*To be Continued.*)

ON THE USE OF POTASSIUM OR SODIUM BROMIDE AS A SOURCE OF BROMINE FOR UREA ESTIMATIONS.

By C. H. Collings.

In urine analysis the estimation of urea is usually carried out by means of the interaction of sodium hypobromite and the urine to be analysed. Sodium hypobromite, as such, cannot be kept in stock, and has therefore to be made shortly before use, by the addition of bromine to sodium hydrate solution. Bromine in its native form needs extreme care in handling if unpleasant consequences are to be avoided, it is expensive, and its carriage is costly and subject to delay, and in some cases (such as India) is prohibited altogether. It follows, therefore, that a method of obtaining and handling bromine that is at once safe in even unskilled hands, is economical, and is unaffected by such prohibition, may be regarded as of some practical utility. I am not disregarding the usual laboratory methods for the evolution of bromine from its compounds, but the advantage in practice of the method here described is evident.

The apparatus previously described and figured respectively in *The Chemical News* (this vol., pp. 55 and 95, Jan. 26 and Feb. 9) is used.



It is connected up with an aspirator or pump, and air is drawn steadily through it during the whole operation. The rôle of the air is rather important. It not only exercises an obviously useful mechanical function, but directly contributes to the separation and removal of the Br from the mixed fluids in which it first finds itself on disengagement from its chemical tie with potassium or sodium, the air passing *through* the mixed fluids from bottom to top.

The method is as follows: Make a stock solution of potassium or sodium bromide, in the proportions of 10 grams of potassium bromide to 25 cc. of distilled water (or NaBr 8 gr. to 25 cc. water). Twenty-five cc. of sodium hydrate solution of the usual hypobromite formula are introduced into HJ via the cup H, and its tap turned off. Fifteen cc. of nitric are placed in A, and at once run into MC and the tap turned off. Twenty cc. of KBr or NaBr solution are placed in W.* The aspirator is now started, and the tap of W turned on, about 40 drops only admitted, and the tap closed again. The aspirator must be kept going during this and the whole of the subsequent operations. (Should a break be necessary for later readjustment, the tap W must be turned off meantime.)

A curious feature now arises. The mixed bromide solution and the acid develop a strong reddish colour, which is transparent. This persists for about three minutes; then, with remarkable suddenness, an opacity develops in the mixture and becomes absolute. This, of course, is the sign of bromine evolution; the air current picks it up, and the sodium hydrate solution in HJ begins to show a yellow tinge (hypobromite formation); and the tap of W should at once be turned on to give 60 drops a minute or faster, provided that no bromine is observed to condense on the walls of MC, or sediment just over its discharge tap at the bottom. Brown fumes of nitrous acid may also be observed in the air in MC; these are also carried over and neutralised by the sodium hydrate, of which the formula provides an ample margin for spare alkalinity.

The air should be kept passing after all the bromide solution is in and until the mixed acid and bromide loses its opacity and regains its former deep orange-red transparency. The hypobromite will now be ready for use and may be drawn off by the delivery tap HD.

The obvious equations for the reaction are:—

$$KBr + HNO_3 = KNO_3 + HBr.$$
$$2HBr + HNO_3 = Br_2 + H_2O + HNO_2.$$

Should any crystals (KNO_3) be precipitated at the bottom of MC, they are readily soluble in a little water, subsequently.

As regards cost, that of a 2.2 cc. tube of bromine is about 7d.; of potassium bromide to produce an equivalent amount, somewhere between a halfpenny and a penny. To this must be added the value of 15 cc. of nitric acid.

The details of the apparatus not already described are as follows: I is the air inlet to valve V—this is nearly filled as shown with sodium hydrate solution to trap any back pressure of bromine. BD is the tube that delivers the free bromine into HJ containing the waiting sodium hydrate solution, which (HJ) is supported on WS. The aspirator or pump is connected up at P. The large jar, RJ, takes the residual fluid from the operation at its conclusion, via the tap below MC, and is periodically syphoned empty via the tube RD, discharging at O.

* *The full amount to correspond to 2.2 cc. Br should be about 27.5 cc., but this really represents an excess over usual needs.*

SCIENTIFIC INVESTIGATIONS ON METAL POLISHING AND GRINDING.

A lecture was given recently at the Chamber of Commerce, Birmingham, by *Mr. Dartrey Lewis, M.Met., describing an* investigation on the materials used in metal polishing, which he has undertaken *for the British Non-Ferrous Metals Re*search Association.

This work has been carried out at the Sheffield University, under the supervision of Professor Desch, F.R.S., Dean of the Faculty o Metallurgy.

In introducing the lecturer, Dr. R. S. Hutton, Director of the British Non-Ferrous Metals Research Association, explained that the lecture would describe the first fruits of one of a series of researches, undertaken by this Association, on problems of direct practical importance to the Metal Industries. The polishing process played a very important part in the production of every variety of metal articles, an din general, accounted for a high fraction o fthe cost of production. In Sheffield and Birmingham, buffers and metal polishers totalled many thousands, their work was laborious and frequently highly skilled, but little had been done to explore possibilities of improvement. A previous investigation with which he had been connected had been devoted to the more *human side of the process, and in connec*tion with this, he had visited a French factory, where an output in spoon and fork *buffing of two to three times that usual in* this country had been achieved. Such cases should serve as an incentive to industrial research.

Mr. Dartrey Lewis explained that he had devoted his attention to investigating the fundamental properties of the materials used in metal polishing, sand, pumice, emery, etc. Methods had been devised for measuring the abrading or cutting power of these materials on brass and other metals in the loose powdered form in which they are generally used. The relative durability of the materials, or the useful life of their grains before they broke down into too fine a state of division to effect any more useful grinding, had also been measured.

Information of this nature appeared to be completely lacking, although, of course, the experts in the trade possessed a vast amount of accumulated experience. The necessity for quantitative comparative measurements was all the greater, because in recent years new abrasive materials, such as artificial corundum and carborundum had been discovered of much better grinding power, and of greater durability. This experimental work supplied certain basic information, but it was for the industry to consider how far and in what directions one material was superior to another for any given works process. It was, however, suggested that advantage might be taken of some of the superior materials to remove the rougher and thicker layers of metal, whilst still using sand and pumice for smoothing off preparatory to the real polishing.

Mr. Lewis also briefly described his experiments in comparing chromic oxide and rouge for polishing steel and silver.

The British Non-Ferrous Metals Research Association is extending the investigation to "glazing" and other abrasive processes, *in which the abrasives are fixed to* wheels by glue.

In view of the widespread use of polish*ing processes it is hoped that this work will* attract to the Association the support of many firms in branches of the metal industry hitherto unrepresented in its membership.

NOTE ON p-NITROBENZYL-PYRIDINIUM SALTS.

By H. H. Grainger, B.Sc., A.I.C.

In the course of some experiments on the tinctorial properties of azo-dyes containing the pyridinium group it became necessary to prepare dyes from aminobenzylpyridinium salts. Lellmann and Pekrun (Annalen, 1890, CCLIX., 52) found that p-nitrobenzylchloride reacts easily with pyridine to give a quaternary salt, although they did not analyse the product, which they describe as forming yellow prisms which sinter at 90° and melt at 103°. They, however, were obviously dealing with a very impure product, and it has now been found that if the chloride is purified by recrystallisation from a mixture of alcohol and ether, it forms a snow-white crystalline powder which melts and decomposes sharply at 208°. (Found: Cl = 13.9. $C_{12}H_{11}O_2N_2Cl$ requires Cl = 14.2 per cent.)

The corresponding *bromide* is readily obtained by the action of pyridine on p-nitrobenzylbromide, and is best purified by recrystallisation from alcohol and ether. It melts at 222°. (Found: C = 48.6, Br

= 27.0. $C_{12}H_{11}O_2N_2$ Br requires C = 48.8, Br = 27.1 per cent.)

The addition of picric acid to a solution of the chloride or the bromide gives an immediate precipitate of the very sparingly soluble *picrate* which can be recrystallised from boiling water and then forms beautiful glistening yellow needles which melt at 172°. (Found: N = 15.8, $C_{18}H_{13}O_9N_5$ requires N = 15.8 per cent.)

By reducing aqueous solutions of the chloride by means of tin and hydrochloric acid, solutions of the aminobenzylpyridinium salt can be obtained. These were sulphuretted hydrogen , and the result-freed from tin in the usual way by ing solution then diazotised and coupled with β-naphthol, dimethylaniline and R-salt. By this means very soluble, red, basic dyes were obtained, but these proved to be far too unstable to be of any technical value.

Sir John Cass Technical Institute,
Jewry St., Aldgate, London, E.C.3.

THE SPEED OF CHEMICAL REACTION THROUGH A SOLID.

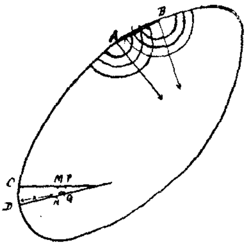
By C. D. Niven.

Much work has been done on Chemical Reaction in Solution, but the reactions of a solid with a solution seem to have fallen into the background. There are, however, many reactions of this kind.

The object now in view is to determine the theoretical time for a reaction to go through a solid of definite shape and size, the solvent being semipermeable to the solid.

Two cases arise. First, when the solute, *i.e.*, the reactive part of the solution, renders the solid more impermeable to the solvent, and secondly, less impermeable; but as it is the permeability after reaction is complete that determines the speed of reaction, the former of these cases is the important one. It is very important in such a case to know when the reaction has reached the centre of the body. Obviously the shape of the body would determine to some extent the time required to reach the most distant point from the surface, and a small increase in thickness in certain bodies might cause enormous increase in the time required to complete the reaction, if the material of which the body was composed became very impermeable after the reaction.

In the case of a solid body in a solution which reacts with the solid body semipermeable to the body before and after reaction, it is seen that each point on the surface of the body is a starting point for reaction.



Taking a point A on the surface, the chemical can be supposed to find its way into the solid like a ray of light shining through a pin-hole on a surface and spreading in concentric spherical shells. If a point B be taken near the point A, similar currents start in all directions, but the currents from B resolved along BA, and which act in that direction, are counterbalanced by the currents emanating from A resolved along AB in direction AB. *Therefore the main reaction travels perpendicular to the line AB; that is to say the reaction travels into the body in the direction of the normal to the curve or surface.*

As the solid is semipermeable to the solvent in which the chemical is dissolved, it is reasonable to imagine that the solvent really acts as a carrier. For simplicity it is assumed that the body is cylindrical in shape. This permits dealing with a curve instead of a surface, as the reaction would clearly travel at the same speed through any cross-section.

Let C D N be a section, C and D two points near on the surface, and CM and DN normals respectively at C and D; and let the reaction reach M and N at the same time, say t, and let it reach P and Q in time δt.

Let CM = x and MP = δx.

Then as C and D are near CN = x and NQ = δx, the area acted on in time δt is MNQP = $MN\delta x$.

The amount of chemical required to act on this area is proportional to the area.

The distance the chemical has to come is CM = x.

But as CD is *greater* than MN in a convex curve, *the chemical could travel* much more quickly near CD than near MN, as the molecules would pack up together as they travelled in. The solid material only being semipermeable to the solvent will have a certain restraining effect to the reaction. This will depend on the nature of the substances reacting, and in most cases on the concentration of the solution.

In order to visualise what has been said above, the reader may imagine an area covered with causeway or concrete, which has to be covered to a depth of a foot with sand, beginning from the outside—as many vehicles of transport being allowed to work. The farther from the edge, the harder the work becomes, as in the first place the *distance is greater, in the second place* fewer vehicles can work as there is no room near the centre, and in the third place the *sand renders the ground to be covered* more difficult. From this analogy, it is easy to see that the number of molecules that could pass in at a time, *i.e.*, number of vehicles, is proportional to the width of the passage or road, and in a wedge-shaped passage the number would be proportional to the area of wedge divided by the length of distance.

Turning again to Fig. I., the time to complete the chemical reaction on the small area MNQP is (1) proportional to distance chemical has to come, (2) inversely proportional to average width of passage, and (3) proportional to amount of chemical required,

i.e., Time $= K\, x \quad \frac{x}{AMNB} \times MN\delta x$
X

$$= K \frac{x^2 MN\delta x}{AMNB}$$

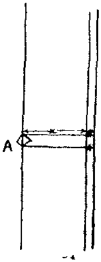
∴ Total time to react from outside to a distance x_1 is

$$\int_0^{x_1} \frac{K\, x^2\, MN\delta x}{AMNB}$$

In the case of a body of any shape *instead of the piece of curve* **MN**, there is a small curved area, and instead of the wedged area AMNB is a frustum of a cone.

Three important forms of solid deserve special investigation, viz., the plane surfaced plate, the cylinder of circular section, and the sphere.

In the *first case* when the surface is plane the normals are all parallel and the line of the reaction always advances parallel *to the surface.*



Considering a small area, A, on the surface, *the time to react at a distance x on* same size of area is

$$K\, x \quad \frac{x}{Ax} \quad X \quad A dx$$

$$\text{Total time} = \int_0^{x} K\, x\, dx = \frac{Kx^2}{2}\Big|^{x_1}$$

$$= K \frac{x_1^2}{2}$$

In the case of a cylinder of circular section, the value of MN in terms *of* x *and* the radius of the circle is required, and also a value for the area AMNB in the same terms. If "a" be the radius of circle and α = angle AOB where O is the centre, then MN = $\alpha\,(a-x)$ - - - (1)

Area AMNB = AOB - MON

$= \frac{1}{2}\alpha\,(a^2 - \overline{a-x}^2)$

$= \frac{1}{2}\alpha\,(2ax - x^2)$ - - - - (2)

Hence, total time to depth x,

$$\int_0^{x_1} \frac{K\, x^2\, \alpha\, \overline{a-x}\, dx}{\frac{1}{2}\alpha\, x\,(2a-x)}$$

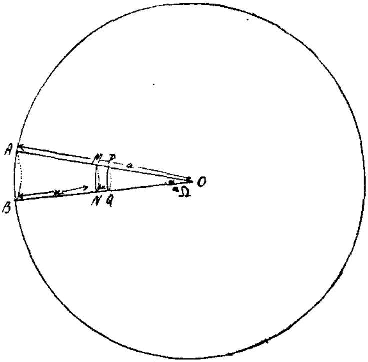
$$\int_0^{x_1} \frac{K\,2\,x\,(a-x)\,dx}{2a-x}$$

Substituting z for $2a-x$ and integrating,

$$\text{Total time} = 2K\left[3aZ-Z^2\right]_{2a-x_1}^{2a} - 4a \left.\log Z\right|_{2a-x_1}^{2a}$$

To complete the reaction to the heart put $x_1=a$. The total time then becomes $Kx \cdot 2276a^2$.

In the third case, viz., a sphere of radius "a," it is required to find a value of the small area MN and the volume of the frustum ABNM.



Let the area AB subtend a solid angle Ω at the centre O. Then the area MN is

$\Omega : \overline{a-x}^2$ - - - - - - - (1)

and the volume of the frustum ABNM is

$\frac{1}{3}\Omega[a^3 - \overline{a-x}^3]$ - - - - - - (2)

Substituting in the general formula found above, the total time to a depth x_1 is

$$\int_0^{x_1} \frac{K : x^2 : \Omega : \overline{a-x}^2 dx}{\frac{1}{3}\Omega[a^3 - \overline{a-x}^3]} = 3K\int_0^{x_1} \frac{\overline{a-x}^2\; x\,dx}{x^2-3ax+3a^2}$$

On integration, the total time is

$$= 3K\left.\frac{x^2}{2}\right|_0^{x_1} + 3Kax\Big|_0^{x_1} + 3Ka^2 \log (x^2-3ax+3a^2)\Big|_0^{x_1}$$

$$- 3\sqrt{3}K\,a^2 \tan^{-1}\left[\frac{x-\frac{3}{2}a}{\frac{\sqrt{3}a}{2}}\right]$$

$$= \frac{3K\,x_1^2}{2} + 3K\,a\,x_1 + \frac{3K\,a^2}{2}\log\frac{x_1^2-3ax_1+3a^2}{3a^2}$$

$$-3\sqrt{3}\,Ka^2\left[\tan^{-1}\left(-\tfrac{1}{3}\right) - \tan^{-1}\left(-\sqrt{3}\right)\right].$$

When the reaction reaches the heart of the sphere $x_1=a$ and the total time becomes

$$K\,a^2 \times 0.1271.$$

The times then for a plane plate of thickness $2a$, a circular cylinder of radius a, and a sphere of radius a, are in the proportion of 0.5 : 0.2276 : 0.1271, no matter what the reacting chemical is, or its strength, provided, of course, it does react according to the original assumption.

To demonstrate, the following is a practical example. In a bath of formaldehyde various pieces of casein plates were steeped from 3 millimetres upwards, and various pieces of cylinders, all circular in section and solid.

These were watched and the times when the reaction was completed were noted. Each piece, when ready, was dried and measured in a micrometre. The values for plates were found to be very near the curve $y=888x^2$, where y=time and x thickness.

A curve may then be plotted and the points found by experiment marked

The following is a table showing the times got by experiment and the times agreeing with the theoretical curve for plates $y=0.888x^2$:—

Thickness in mm.	3.3	4.6	5.8	7.5	13
Expt., days	9	19	32	50	140
Theor., days.	9.6	18.8	29.9	49.9	150

For the rods the curve is fixed assuming the solution is the same as for the plates, viz., $y=0.404x^2$, and the following are the experimental values and the theoretical values of the times for certain thicknesses of rods:—

Diameter in mm.	5	7.8	10	12.7	17.9
Expt., days	11	25	38	61	133
Theor., days	10.1	24.6	40.4	65.2	130

The values are sufficiently near to justify the theory proposed above as the difficulty in getting the exact end point in a very slow reaction is of course great.

Owing to the expense of getting moulds made for spheres, it has been impossible to get *a series of readings, but one sphere* was taken and compared under similar conditions with a 5 mm. plate or sheet—*more rapid conditions than those under* which original pieces were tested.

The 5 mm. plate took 14 days and the *sphere 13 mm. in diameter took 25 days.* Calculating what time this sphere would have taken if the 5 mm. sheet took 14 days, we get

$$\frac{0.1275}{0.5} \times \frac{169}{25} \times 14 = 24.05 \text{ days.}$$

This supports the theory.

GENERAL NOTES.

ACETONE FOR THE UNITED STATES.

Mr. G. Campbell, H.M. Consul-General in San Francisco, reports that a local firm of manufacturers of compressed acetylene gas are desirous of getting into touch with United Kingdom manufacturers of acetone for the purpose of purchasing supplies for use in their business. The acetone must comply with the British War Office specifications. The enquirers are understood to enjoy a very good standing and reputation, and they stipulate that quotations should state price per pound F.A.S. British shipping port on quantities of approximately 30,000 pounds. The price must be in competition with that of 21 cents per pound in the United States.

An import duty of 25 per cent. *ad valorem* is levied on acetone imported into the United States.

The name and address of the firm in question may be obtained by manufacturers on application to the Department of Overseas Trade (Room 52).

Sir Eric Geddes, President of the Federation of British Industries, delivered an important speech on the Trade Future, at Birmingham, on Tuesday, March 13, on the occasion of the Annual General Meeting of the West Midland Branch of the F.B.I.

The Department of Overseas Trade has just issued a small explanatory handbook, indicating the aims and objects of the Department, and the directions in which it is intended to assist and develop commerce.

CRESYLIC ACID FOR THE UNITED STATES.

Mr. D. H. M. Sinclair, H.M. Consul-General at Philadelphia, reports that a local firm of wholesale oil dealers desire to receive from U.K. manufacturers quota*tions for cresylic acid 97 to 99 per cent.* pure, straw colour, and 95 to 97 per cent. pure, dark, as well as lower grades.

The *name of the firm may be obtained* by interested firms upon application to the Department of Overseas Trade.

The *British Vice-Consul at Constantza* (Mr. Tottenham Smith) reports that a local authority desires to be put in touch with United *Kingdom suppliers of medico*-surgical instruments necessary for a complete polyclinic, including X-ray equip*ment, and to receive copies of catalogues,* in French if possible.

Further particulars, together with the *name and address o the enquirer, can be* obtained by firms on application to the Department of Overseas Trade.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, MARCH 15, AT 4.30 P.M.

Papers read:—

J. A. CARROLL. *Note on the Series-Spectra of the Aluminium Sub-Group.* Communicated by Prof. A. Fowler, F.R.S. (*Paper read by communicator.*)

In contradistinction to the alkali metals, the highest terms in the known series-spectra of the elements of the aluminium subgroup are the common limits of the sharp and diffuse series, and not the limits of the principal series.

Measurements of the ionisation and resonance potentials for thallium, however, have suggested that there might be a yet undiscovered principal series in the far ultra-violet, the limit of which would be the greatest term and would correspond with the normal state of the thallium atom. In the present paper it is pointed out that against this is the absence of positive evidence of such a series, and the easily reversible nature of the lines of the subordinate series in the arc spectra.

It seemed that valuable evidence as to the normal state of the atoms might be afforded by an investigation of the absorp-

tion spectrum of the cool vapour of one of the elements in question. Thallium was chosen as an easily obtainable and representative member of the group, which is not too difficult to deal with experimentally. It was found that the lines obtained in absorption were members of the subordinate series, thus confirming the original series arrangement. The results are in accordance with the latest developments of Bohr's theory, according to which two of the outermost electrons in the thallium atom are in 6_1 orbits and one is in a 6 orbit.

W. E. CURTIS, D.Sc. *The Structure of the Band Spectrum of Helium.—II.* Communicated by Prof. O. W. Richardson, F.R.S.

Seven of the doublet bands previously examined by Fowler have been studied in detail, with the following results:—

1. Tables of wave-lengths, etc., and least-square empirical formulæ were given for the constituent series of each band.
2. The structure of the bands was considered. In the main this is in agreement with the requirements of the quantum theory, but some important discrepancies were noted and discussed in connection with Kratzer's half-quantum hypothesis.
3. Values for the moments of inertia of the molecules concerned were derived by a graphic method and used to verify certain theoretical conclusions.
4. Several perturbations were recorded (the first examples in this spectrum), and their significance is discussed.
5. A new combination law was tested and found to be obeyed.
6. Some peculiarities noted by Fowler were verified and explained.

G. C. STEWARD. *Aberration Diffraction Effects.* Communicated by Prof. A. S. Eddington, F.R.S.

Diffraction theory would indicate that the image of a luminous point, given by a symmetrical optical system, should be a system of luminous rings, and this was investigated by Airy in 1834; geometrical theory, on the other hand, leads to a consideration of several types and orders of aberration—the more common ones being better known as the "Five Aberrations of Von Seidel." They are: Spherical Aberration, Coma, Astigmatism, Curvature of the Field, and Distortion. These are well known and have been investigated by a number of writers. In the present paper a consideration is undertaken of the modification of the "ideal" diffraction pattern produced by these geometrical aberrations.

The method adopted depends upon the Eikonal Function of Bruns, and a summary of the properties of this function was given, therefore, in Part I. of the paper. Part II. dealt with the Aberration Diffraction effects.

Throughout Parts I. and II. it is assumed that the stops of the optical system are circular, with centres upon the axis of symmetry; and this is generally the case. Occasionally, however, other stops are used, and in Part II. of the paper is undertaken a consideration of the diffraction effects of such in the presence of the various geometrical aberrations. The precise forms of aperture considered are the following:—

1. The usual circular aperture, but with the central portion stopped out.
2. One (or two parallel) narrow rectangular aperture.
3. A semi-circular aperture.

Papers read in title only:—

LORD RAYLEIGH, F.R.S. *Further Observations on the Spectrum of the Night Sky.*

This paper is a continuation of the author's previous studies on the spectrum of the night sky.

Specially designed spectrographs having a working aperture of $f/.9$ are described. The northern and southern horizons have been photographed simultaneously on the same plate, and the aurora line recorded almost down to the horizontal direction in each. It is ound, however, that there is no marked difference of intensity between them.

The negative nitrogen bands appear fairly often in photographs of the night-sky spectrum exposed for several nights running in the North of England. Similar spectra taken in the South of England do not show them. As previously shown they are always strong in the Northern Lights in Shetland.

The spectrum of the night sky shows two bright lines or bands in the blue and violet, the approximate positions, as nearly as they could be determined on the very small scale spectra, were 4200 and 4435. The origin of these is not known. In addition, there is the aurora line 5578, also of unknown origin, and the dark Fraunhofer lines H and K. These various lines, bright and dark, are shown on a photograph sent

to the author by Dr. E. C. Slipher, which was taken about the same time.

LORD RAYLEIGH, F.R.S. *Studies of Iridescent Colour, and the Structure producing it. IV.—Iridescent Beetles.*

It is shown that some of the iridescent beetles which have striking metallic colours show band systems in the spectrum of the reflected light. Two such spectra are reproduced.

The first, from *Pelidnota sumptuosa*, shows a central maximum bordered on either side by subordinate maxima in exactly the way that reflection from a quite uniformly spaced assemblage of thin plates would require. The number of planes calculated to be required in this case is no less than 34. A Lippmann film shows a similar spectrum.

The second spectrum is from one of the golden beetles, *Callodes parvulus*. The bands are accounted for on the supposition of two assemblages, each consisting of several reflecting planes, the distance between the assemblages being about 8μ. This would result in a series of equally spaced bands over a limited range of the spectrum as observed.

The possibility of either of these spectra being produced on the alternative theory of surface reflection is discussed, and is found to require a number of special suppositions which seem very difficult of acceptance.

PROF. J. W. NICHOLSON, F.R.S. *Oblate Spheroidal Harmonics and their Applications.*

PROF. J. W. NICHOLSON, F.R.S., and PROF. F. J. CHESHIRE. *On the Theory and Testing of Right-angled Prisms.*

PROF. J. C. MCLENNAN, F.R.S., and D. S. AINSLIE. *On the Fluorescence and Channelled Absorption Spectra of Cæsium and other Alkali Elements.*

Cæsium has been shown to exhibit a fluorescence and a channelled absorption spectrum in the neighbourhood of $\lambda = 2000$ when the vapour of the element is traversed by white light. In the absorption spectrum the bands were found to be separated by intervals that were simple multiples of 24 A. Like sodium, potassium has been shown to exhibit channellings in its absorption spectrum in the neighbourhood of the second member of its doublet series. The fluorescence spectrum of rubidium has been photographed, and the wave-length of its bands measured. Indications have been obtained of channelling in the absorption spectrum of lithium in the near ultra-violet region.

W. STILES, Sc.D. *The Indicator Method for the Determination of Coefficients of Diffusion in Gels, with special reference to the Diffusion of Chlorides.* Communicated by W. B. Hardy, Sec. R.S.

1. An indicator method is described by which the coefficients of diffusion of chlorides, sulphates and other substances can be simply determined.

2. The coefficients of diffusion of a number of chlorides in 0.5 per cent. agar-agar gels are recorded.

3. The effect of temperature on the coefficient of diffusion of these chlorides has been investigated. The coefficient increases at a greater rate per degree rise in temperature the higher the temperature; the relation between coefficient of diffusion and temperature in gels is thus not a linear one as is usually assumed to be the case for free diffusion in water.

4. The coefficient of diffusion decreases with increasing concentration of gel. Empirical expressions are given to record the relation between coefficient of diffusion and concentration of gel.

5. The coefficient of diffusion increases with decreasing concentration of the diffusing salt. An empirical expression is given to express approximately the relation between coefficient of diffusion and concentration of diffusing salt in the case of sodium chloride.

H. T. FLINT. *A Generalised Vector Analysis of Four Dimensions.* Communicated by Prof. O. W. Richardson, F.R.S.

The paper gives an account of an invariant Vector Calculus in a notation which is the natural generalisation of that of Gibbs. Contravariant and covariant vectors are related by means of an operator—the extended idem-factor, and tensors are introduced as dyadics and polyadics. The expressions familiar in the Tensor Calculus of Riemann and Christoffel appear very simply in the analysis. Separated points are connected by the geodetics and a simple definition of parallelism at two points leads at once to the Weyl parallel displacement relations.

ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on Friday, March 23 (at 9 o'clock) will be delivered by SIR ERNEST RUTHERFORD, LL.D., D.Sc.,

F.R.S., M.R.I., Prof. of Natural Philosophy; Cavendish Prof. of Experimental Physics, Univ. of Cambridge. The subject is *Life History of an Alpha Particle from Radium.*

Saturday, March 24. — SIR ERNEST RUTHERFORD, LL.D., D.Sc., F.R.S., M.R.I., Prof. of Natural Philosophy, on *Atomic Projectiles and their Properties.* (Lecture VI.)

ROYAL AGRICULTURAL SOCIETY.

PROCEEDINGS AT MONTHLY COUNCIL, HELD AT 16, BEDFORD SQUARE, W.C.1, ON WEDNESDAY, MARCH 7.

Lieut.-Col. E. W. Stanyforth (President) in the Chair.

Among the reports of the various Standing Committees presented and adopted was the following:—

Chemical Report.

Lord Bledisloe, in the absence of Mr. Luddington, reported that the Consulting Chemist had presented to the Committee a list of the samples analysed by him for members during the past month.

The Chairman had reported that he, together with Mr. J. W. Pearson, had had an interview with the Minister of Agriculture on the question of the new Bill to amend the existing Fertilisers and Feeding Stuffs Act. Sir Robert Sanders had promised to write his decision in the course of a few days. As this reply had not yet been received, it was decided that a further meeting should not be called until the promised reply from the Ministry was in the hands of the Chairman. Should, however, a considerable time elapse, the Chairman would call another meeting of the representatives.

Dr. Voelcker had submitted various matters arising out of his correspondence, which dealt chiefly with castor oil bean in feeding cakes, basic slag which was insufficiently ground, fish meal with excessive oil, and the cost of burning chalk for lime.

The Committee received with regret the report of the death of Mr. F. J. Lloyd, formerly senior assistant in the Society's laboratory.

Lord Bledisloe, in moving the adoption of this report, referred to the recent death of Mr. Lloyd, who at one time had been an assistant in the Society's laboratory. Mr. Lloyd had done valuable work during his lifetime as an agricultural chemist.

THE GEOLOGICAL SOCIETY.

ANNUAL GENERAL MEETING.

February 16.—Prof. A. C. Seward, Sc.D., F.R.S., President, in the Chair.

The Reports of the Council and the Library Committee were read.

The completion of Vol. LXXVIII. of the Quarterly Journal was announced, as also the publication of the Lists of Geological Literature for 1914 and 1922.

The President presented the Wollaston Medal to William Whitaker, F.R.S.

The Murchison Medal was presented to Prof. John Joly, F.R.S., the Lyell Medal to M. Gustave F. Dollfus, the For.Memb.-G.S.

The Bigsby Medal was awarded to Mr. Edward Battersby Bailey, M.C. Mr. G. W. Lamplugh, F.R.S., acknowledged it for the recipient.

The ballot for the Council and Officers was taken, and the following were declared duly elected for the ensuing year:—*Council*: Charles William Andrews, B.A., D.Sc., F.R.S.; Frederick Noel Ashcroft, M.A., F.C.S.; Prof. Percy George Hamnall Boswell, O.B.E., D.Sc.; Prof. William S. Boulton, D.Sc., Assoc.R.C.Sc.; James Archibald Douglas, M.A., B.Sc.; Gertrude Lilian Elles, M.B.E., D.Sc.; John William Evans, C.B.E., D.Sc., LL.B., F.R.S.; John Smith Flett, O.B.E., M.A., LL.D., D.Sc., M.B., F.R.S.; Sir Archibald Geikie, O.M., K.C.B., D.C.L., LL.D., Sc.D., F.R.S.; Frederick Henry Hatch, O.B.E., Ph.D.; Robert Stansfield Herries, M.A.; Prof. Owen Thomas Jones, M.A., D.Sc.; William Bernard Robinson King, O.B.E., M.A.; William Dickson Lang, M.A., Sc.D.; Richard Dixon Oldham, F.R.S.; Prof. Sidney Hugh Reynolds, M.A., Sc.D.; Prof. Albert Charles Seward, Sc.D., F.R.S., F.L.S.; Walter Campbell Smith, M.C., M.A.; Sir Aubrey Strahan, K.B.E., Sc.D., LL.D., F.R.S.; Sir Jethro J. Harris Teall, M.A., D.Sc., LL.D., F.R.S.; Herbert Henry Thomas, M.A., Sc.D.; Prof. William Whitehead Watts, LL.D., Sc.D., M.Sc., F.R.S.; and Henry Woods, M.A., F.R.S.

Officers: President, Prof. Albert Charles Seward, Sc.D., F.R.S., F.L.S.; Vice-Presidents, John William Evans, C.B.E., D.Sc., LL.B., F.R.S.; Richard Dixon Oldham, F.R.S.; Herbert Henry Thomas, M.A., Sc.D.; and Prof. William Whitehead Watts, LL.D., Sc.D., M.Sc., F.R.S. Secretaries, Walter Campbell Smith, M.C., M.A., and James Archibald Douglas,

M.A., B.Sc.; Foreign Secretary, Sir Archibald Geikie, O.M., K.C.B., D.C.L., LL.D., Sc.D., F.R.S.; and Treasurer, Robert Stansfield Herries, M.A.

The thanks of the Fellows were unanimously voted to Prof. E. J. Garwood and Dr. G. T. Prior, retiring from the office of Vice-President, and also from the Council; and to the other retiring members of Council: Dr. F. A. Bather, Mr. T. C. Cantrill, and Mr. J. F. N. Green.

FEBRUARY 28. 1923.

Prof. A. C. Seward, Sc.D., F.R.S., President, and, afterwards, Prof. W. W. Watts, Sc.D., F.R.S., Vice-President, in the Chair.

The list of donations to the Library was read.

The following communications were read:—

The Late Glacial Stage of the Lea Valley (Third Report), by SAMUEL HAZZLEDINE WARREN, F.G.S.

The Elephas-antiquus Bed of Clacton-on-Sea (Essex), and its Flora and Fauna, by SAMUEL HAZZLEDINE WARREN, F.G.S.

The two papers were followed by discussions.

ROYAL SOCIETY OF ARTS.

The Cantor Lecture (3), entitled *Accurate Length Measurement*, was read on Monday, March 19, by J. E. SEARS, JUN., C.B.E., M.A., M.I.M.E., ASSOC.M.INST.-C.E., Superintendent of Metrology Dept., National Physical Laboratory.

At the Ordinary Meeting on Wednesday, March 21, a paper entitled *Some Curious Phenomena of Vision, and their Practical Importance*, was read by F. W. EDRIDGE-GREEN, C.B.E., M.D., F.R.C.S., Special Examiner and Adviser of the Board of Trade on Colour-Vision and Eyesight. The paper was illustrated with lantern and other demonstrations. Professor E. H. Starling, C.M.G., M.D., Sc.D., F.R.S., presided.

THE CHEMICAL SOCIETY.

The Annual General Meeting of the Chemical Society was held on Thursday, March 22.

BUSINESS.

The Report of the Council for the year ended December 31, 1922, was received and adopted.

The President, Sir James Walker, D.Sc., F.R.S., delivered his Presidential Address, entitled *Symbols and Formulæ.*

THE OPTICAL SOCIETY.

A meeting was held at the Imperial College, Imperial Institute Road, South Kensington, at 7.30 p.m. on Thursday, March 22, 1923, when the fifth of the series of lectures dealing with the evolution and development of optical instruments was delivered.

Subject: *Surveying and nautical instruments from a historical standpoint.* Lecturer: DR. L. C. MARTIN.

The lecture was illustrated by exhibits from the collection in the Science Museum, Kensington (by the kind permission of the Director, Col. Lyons, F.R.S.).

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society was held in the Latin Theatre, The University, Edmund Street, Birmingham, on Wednesday, March 21, 1923.

The following papers were read and discussed:—

A Rapid Method of Testing the Durability of Glassware, by H. S. BLACKMORE VIOLET DIMBLEBY, B.Sc., and PROF. W. E. S. TURNER, D.Sc.

The Corrosion of Fireclay Refractory Material by Glass and Glass-making Materials, by DONALD TURNER, B.Sc.TECH. (Lately Salter's Research Fellow), and PROF. W. E. S. TURNER, D.Sc.

The Effect of Saltcake in Corroding Fireclay Materials, by EDITH M. FIRTH, B.Sc., F. W. HODKIN, B.Sc., and PROF. W. E. S. TURNER, D.Sc.

By the courtesy of the directors, a visit was made to the works of Messrs. Austin Motor Co., Ltd., Northfield, Birmingham.

"DIRECTORY FOR THE BRITISH GLASS INDUSTRY."

This Directory, the publication of which has been unavoidably delayed, will be ready on March 20. It is bound in cloth and contains 384 pages. It may be purchased by members at the very low price of 6s., post free. Members who have not yet ordered a copy should send their order, with remittance, to the Secretary, Society of Glass Technology, Darnall Road, Sheffield.

THE ESTIMATION OF LACTOSE.

By Vincent Edwards, F.I.C.

The determination of milk sugar in various milk products has for many years past been carried out by Fehling's well-known method either volumetrically for O'Sullivan's weight method if the amount large percentages, or by modification of was small. There can be no douht that with certain precautions and experience a rapid and accurate estimation can be made volumetrically, and as the subject is of increased interest owing to the proposed new regulations concerning "total solids" in milk, I venture to put forward a slight modification of the method which I have found useful as giving a much clearer indication of the end of the reaction, the obscurity of which has always been one of the drawbacks of this historic procedure.

I take 10 cc. of milk or other liquid milk product, or one gram of milk powder, dissolve in hot water, make up to nearly 100 cc., and boil with a few cc. of 10 per cent. acetic acid; allow to cool, dilute to 100 cc., filter off the casein; a perfectly clear filtrate should result. Ten cc. of mixed Fehling solution are now run into a small porcelain dish, and before dilution with 40 cc. of distilled water, a pinch (about sufficient to go on the point of a knife) of magnesium tartrate is mixed in. This valuable improvement is due to the late S. A. Vasey. The red precipitate is collected in the centre of the dish, with a ring of clear liquid round the sides, in which the blue colour is seen quite plainly.

My modification is in the subsequent stages. A piece of pure paraffin wax, about the size of a walnut, is put in the dish, the titration is then continued with the usual precautions, and with the additions mentioned a much better end indication can thus be obtained. If a slight excess, about 0.5 cc., of the test solution or a little more is run in, and allowed for, the clear yellow tinge showing the complete absence of copper in the solution is very apparent. As 10 cc. or one gram of the milk proruct is taken, the calculation of the result is quite simple, the factor 0.72 being taken for milk sugar. It is to be desired that in place of the term, "total solids," fuller particulars were given of the ingredients of milk. The public are becoming aware that the fat is not the only constituent worth consideration, and that proteins, sugar and phosphates have their own special value for dietetic purposes.

CORRESPONDENCE.

PROJECTED COMPENDIUM ON COLLOID CHEMISTRY.

To the Editor of The Chemical News.

Sir,—With the assistance of prominent specialists the world over, I am preparing a comprehensive book on Colloid Chemistry, Theoretical and Applied. The extensive and international character of the book is evidenced by the list of those who have already promised contributions.

Many unusual experimental facts and practical applications of colloid chemistry principles are unpublished, and the object of this letter is to ask anyone in any field of science or experience, who may have information of interest, to send me a brief statement for inclusion in the book.

Contributions may consist of a paragraph, a page, or several pages, and will (unless contrary request is made) be duly acknowledged. If possible, they should be submitted in English, and duplicate copies will be appreciated. Authors should state their full names and titles.

The editors of scientific, technical and cultural publications in all countries are asked to disseminate this appeal.—Yours, etc.,

Jerome Alexander, M.Sc.

50, *East 41st Street, New York, U.S.A.*
February 10, 1923.

[A long list of distinguished chemists and scientists of all countries, who have contributed to the knowledge of colloid chemistry, is appended.—Ed., *C.N.*]

THE AUTHENTICITY OF THE LATIN WORKS OF GEBER.

To the Editor of The Chemical News.

Sir,—I was much interested to read Mr. E. E. Whale's letter on the above topic, in your issue for March 9, and the excellent report of Mr. Holmyard's lecture on "Arabian Alchemy and Chemistry," which appeared in the previous issue. In that report you were kind enough to include my own remarks—to which I would draw Mr. Whale's attention—which perhaps sufficiently define my own position towards the question of Geber in the light of Mr. Holmyard's researches; but it may possibly be of use if I briefly expand these here. Like Berthelot, I know no Arabic, and in common with him and other writers

on the history of chemistry, I had to rely, when writing *Alchemy: Ancient and Modern*, upon the translations of Geber's original works, which Berthelot had had prepared for the purposes of his own studies. Judging from these, no other conclusion seemed possible than would appear to be that for adequate translations of these Arabic MSS., and it is to be hoped that Mr. Holmyard might be persuaded to undertake this important work. A translation of Geber's *Book of Properties*, for example, the MSS. of which is in the British Museum, would be especially welcome. Until such translations have been made it may be as well to retain an open mind concerning the question of the authenticity of the Latin works; but certainly the evidence for reversing the decision, arrived at by Berthelot, which Mr. Holmyard has already put forward is, to my mind, very convincing.

As to the different spellings, "Geber" and "Dschabir," these are merely different transliterations of the same Arabic name, and do not refer to different individuals.—Yours, etc.,

H. Stanley Redgrove,
B.Sc., A.I.C., F.C.S.

191, *Camden Road, N.W.1.*
March 10, 1923.

BOOKS RECEIVED.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry, by J. W. Mellor, D.Sc. Pp. X. + 927. Vol. III., 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 63s. net.

Anorganische Chemie, by Dr. Fritz Ephraim. Pp. VIII. + 742. 1923. Verlag von Theodor Steinkopff, Dresden and Leipzig. 8s. 6d., Bound 10s. 2d.

Glue and Gelatin, by Jerome Alexander. Pp. 236. 1923. The Chemical Catalog Co. Inc., 19, East 24th Street, New York, U.S.A. 3 dollars.

Chemical Technology and Analysis of Oils, Fats and Waxes, by Dr. J. Lewkowitsch, M.A., F.I.C. Entirely revised by George H. Warburton. Pp. VIII. + 508. Sixth Edition. Vol. III. 1923. Messrs. Macmillan & Co., Ltd., St. Martin's Street, W.1. 36s. net.

Vital Factors of Foods, Vitamins and Nutrition, by Carleton Ellis, S.B., F.C.S., and Annie Louise Macleod, Ph.D. Pp. XIII. + 391. 1923. Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, W.C.2. 25s. net.

The Mathematical Theory of Relativity, by August Kopff. Translated by H. Levy, M.A., D.Sc., F.R.S.E. Pp. VIII. + 214. 1923. Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C.2. 8s. 6d. net.

The Chemists' Year Book, by F. W. Atack, assisted by L. Whinyates, A.M.C.T., A.I.C. Pp. 1,107. Vols. I. and II. 1923. Messrs. Sherratt & Hughes, 34. Cross Street. Manchester. £1 1s. 9d. (Abroad, £1 2s.).

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

5027—Carmichael . Co., Ltd., J. F.—Means for elevating and controlling supply of acids, etc. Feb. 21.

4965—Durand et Huguenin Soc. Anon.—Manufacture of highly chlorinated hydro-aromatic products containing nitrogen. Feb. 20.

4873—Lamoreaux, W. F.—Manufacture of sulphuric acid. Feb. 20.

5374—Margulies, O.—Production of organic arsenic compounds. Feb. 23.

5308—National Benzone Association.—Process of treating aromatic hydrocarbons. Feb. 23.

4887—Pickett, F. N.—Method of removing chloropicrin from stannic chloride pentahydrate solution. Feb. 19.

Specifications Published this Week.

170302—Chemische Fabriken Vorm.—Process of purifying natural cellular structures containing xanthine derivatives.

192778—Pease. E. L.—Production of material suitable for use as a fertiliser

192842—Akt Ges fur Anilin Fabrikation.—Manufacture of new dyestuffs.

192941—Byrom, J. G., and Attwater, R.—Method of manufacturing formaldehyde condensation products of phenols.

192970—Goldschmidt, H., and Stock, A.—Process for electrolytically manufacturing compact metallic beryllium.

191029—Etablissements Poulenc Freres and Oetchslin.—Manufacture of aliphatic arsenical compounds.

Abstract Published this Week.

191305—Dyes.—Soc. of Chemical Industry in Basle; Basle, Switzerland.
Basle. Switzerland.

Monoazo dyes, yielding fast violet-blue to brown shades when chrome printed on cotton are obtained by coupling diazotized 1-amino-2-oxy-naphthalene-4-sulphonic acid, or a substitution product thereof, with B-resorcylic acid; in examples the diazo compound itself and the nitrated diazo compound are used.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3285.

A NEW DISTINCTION BETWEEN SODIUM AND POTASSIUM.

By C. W. L. Bourlet and W. Thomas.

The elements, sodium and potassium, are so much alike chemically that any point of marked difference between them seems worthy of note.

The following facts, which, so far as we know, are brought forward for the first time, point to a highly interesting difference in the colloidal constitution of the aqueous solutions of the fatty acid salts of potassium and sodium.

It is common knowledge that solutions of sodium oleate of higher concentration than 5 per cent. form a gel on cooling to normal temperatures. Solutions of potassium oleate, on the other hand, may be poured from one vessel to another till the concentration reaches approximately 40 per cent. In the case of the potassium soaps the change of concentration *gradually* increases the viscosity till the mass becomes very viscous, and finally plastic.

In the case of the sodium soaps, however, the change from sol to gel is sudden: slight variations in concentration or temperature induce enormous variations in viscosity.

The addition of phenol or cresol to a potassium soap solution "thickens" it, *i.e.*, the viscosity is increased, the effect being most marked in the case of phenol.

In the case of the sodium soap, however, the effect is reversed: phenols partially destroy the power of gel formation and lower the viscosity. Thus, the addition of 4 per cent. phenol or 2½ per cent. of o, m, or p-cresol to a 10 per cent. solution of sodium soap reduces it to a liquid comparable in viscosity with water at ordinary temperatures. Super-cooling causes it to gel at a lower temperature, depending on the concentration of soap and phenol. Gel formation, however, is always *sudden*; there is no gradual increase in viscosity as in the case of a potassium soap. The addition of sodium hydroxide, carbonate, or silicate in sufficient quantities restores the power of gel formation.

To distinguish between a potash and a soda "soft" soap, it is only necessary to prepare a 15 per cent. aqueous solution, measure the efflux time at constant temperature from a pipette: then add (say) 4 per cent. phenol. In the case of a potash soap the efflux time will be increased; in the case of a soda soap, decreased.

VALENCY.

By William R. Fielding, M.A., M.Sc., (Vict.).

Senior Science Master, King Edward VII. School, Lytham.

(Continued from Page 180.)

(8) Manifestations of Valency.

Valency is manifest in different ways, and it is impossible to differentiate between the different "kinds," if any difference exists. It is a force holding two portions of matter together.

1.—*Valency of Atomic Structure*, holding the positive nucleus and the electrons together. As an atom loses or gains an electron its valency is increased by one unit.

2.—There is molecular valency

(*a*) holding the atoms in an elementary molecule together;

(*b*) holding unlike atoms together in chemical combination.

3.—Polymolecular valency holding two or more like molecules together.

4.—Valency of aggregation, holding a number of molecules together in an aggregation (see *The Chemical News*, 1920, CXX., 3136; CXXII., 3170).

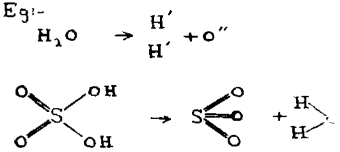
5.—Valency of Cohesion (holding like aggregations together), and adhesion (unlike aggregations).

6.—Valency of solution. This subject will be dealt with in a subsequent article.

Valencies 3, 4, 6 rapidly change with temperature (see *The Chemical News*, 1921, CXXII., 13, 289, etc.).

(9) When to Compare Valencies.

We ought, if possible, to compare the valencies of elements (No. 2 above) under the same conditions, say, either at the B.P. or just at the moment of decomposition.



(Fig 8.)

This would lead us to form a table of valencies like the following:—

Elements.	Valency.
H	1
O	2 (H_2O)
S	4 (SO_2)
C	4 (CH_4 . CO_2)
P	3 (PCl_3)
Hg	2 (*HgO*)

A complete table could only be compiled from data obtained from compounds which can be vapourised without decomposition. No account would be taken of "residual" or "supplementary" valencies (which might exist), but we should at least be consistent.

(10) Periodicity of Valency.

Certain elements which are diatomic in the gaseous state have come to be regarded as *monovalent or standard elements*.

H — H, F — F, Cl — Cl, H — Cl.

Also certain radicles which exist in the "paired" state:—

CH_3—CH_3 C_2H_5—C_2H_5

Also note C_2H_5—H H—OH etc.

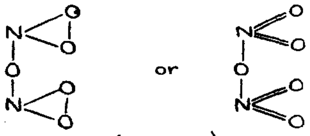
The highest valencies are shown by elements in their oxides (as usually written in their graphical formulæ). From the oxide X_xO_y the valency (which may be as high as 8) is $\frac{2y}{x}$

The highest valencies obtained by different methods are shown below for two series of the periodic table (Fig. IX.).

Groups:-	0	I	II	III	IV	V	VI	VII	VIII
Valency from	He	Li	Be	B	C	N	O	F	—
Oxides:-	0	1	2	3	4	5	—	—	—
Hydrides and Radicles:-	0	—	—	—	4	3	2	1	—
Hydroxides:-	0	1	2	3	4	$HO(NO_2)$	—	—	—
Halides:-	0	1	2	3	4	3	2	1	—
Valency from	Ne	Na	Mg	Al	Si	P	S	Cl	—
Oxides:-	0	1	2	3	4	5	6	7	OsO_4
Hydrides and Radicles:-	0	1	2	3	4	3	2	1	—
Hydroxides:-	0	1	2	3	4	$P(OH)_3$ 3	$SO_2(OH)_2$ 2	$ClO_3(OH)$ 1	— —
Halides:-	0	1	2	3	4	5	4	—	—

Highest Valency Table: (Periodic Series He and Ne).
(Fig IX)

Frequently an element does not reach as high a valency in one compound as in another, although it is surprising how many of these cases can be explained away by the simple process of valency bonds (Fig. X.):—

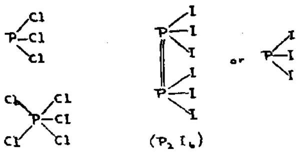


(Fig 10)

In HClO, $HClO_2$, $HClO_3$, $HClO_4$ chlorine is gradually climbing to its maximum valency (7).

Iron is dyad in FeO,
triad in Fe_2O_3,
tetrad in Fe_3O_4 (FeO . Fe_2O_3).

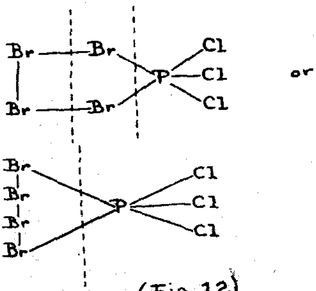
The phosphorus compounds with the halogens show the following valencies (Fig. XI.):—



(Also PF_5, PBr_5.)

(Fig 11)

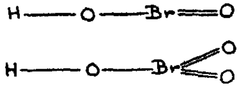
In the crystalline mixed halide, $PCl_3.Br_4$, phosphorus has a still higher valency unless we write it



(Fig 12)

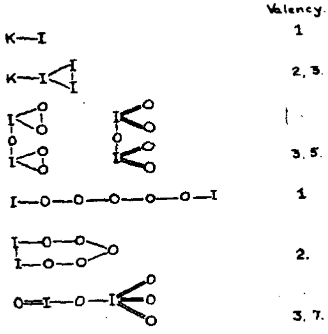
the dotted lines showing the points where decomposition readily occurs (the weak links).

Here bromine would be dyad. Also note



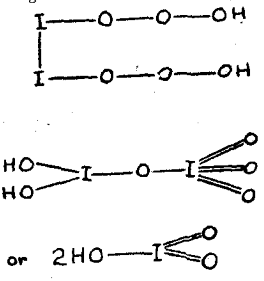
(Fig 13.)

Iodine can be conveniently given any valency between 1 and 7. Thus:—



(Fig 14)

Adding a molecule of water we get

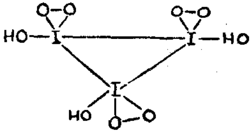


(Fig 15.)

The acid iodates may be regarded as as derived from

$$(HO—I{\overset{O}{\underset{O}{\lessgtr}}})_x$$

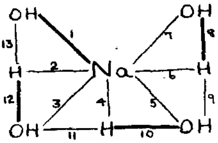
e.g.:- $KH_2I_3O_9$ ($KIO_3 . 2HIO_3$);



(Fig 16.)

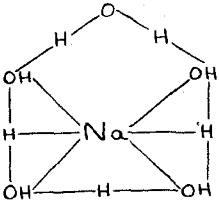
or the valency of iodine may be increased to 7.

Mendeléef pointed out that in many cases the sum of the valencies in oxides and hydrides was 8, and attempts have been made to give such low-valent elements as sodium a valency of 7. The hydrate $NaOH . 3H_2O$ may be written $Na(OH)_4.H_3$, and the compound represented thus (Fig. 17):



(Fig 17.)

Valencies numbers 1, 12, 10, 8, are in the first instance strong; the remainder "residual" or supplementary. After the hydrate has been formed there is probably a redistribution of valency-strength, but these four will remain stronger than the others. Further molecules of water could be added without altering the heptavalent character of the sodium, thus:—



(Fig 18)

(*Note.*—There should be a bond between *Na* and the lowest *H*.)

The valency of hydrogen is more than one, but it can be reduced to 2 by cancelling bonds 9, 11, 13.

(11) THEORIES OF VALENCY.

It would be impossible in the space of a short article to refer to the many different and often ingenious theories put forward to explain the phenomenon of valency.

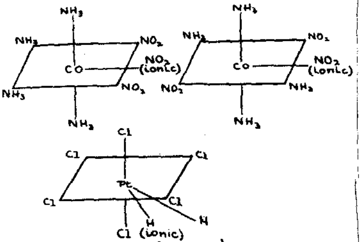
Probably Werner's theory is the one most widely held to-day. Werner supposed that atoms could be connected to each other in two ways, directly and indirectly by the existence of a force which is able to penetrate the envelope of protective atoms or groups which surround the central atom. The latter is directly united with the non-ionisable groups, such as NH_3, NO_2, which are included in the complex radicle and they are not ionised in solution. The valencies so employed are termed the supplementary valencies of the central metal. The principal valencies are used to link on to ionisable groups. These ionisable groups are outside the complex formed through the agency of the supplementary valencies. Werner put the ionisable part of the molecule outside a square bracket, thus:—

$[Co(NH_3)_6]Cl_3$ ↗ This chlorine is ionic, *i.e.*, can be
$[CoCl(NH_3)_5]Cl_2$ — precipitated by a
$[PtCl_2.(NH_3)_4]Cl_2$ ↘ solution of silver nitrate.

In chloroplatinic acid, H_2PtCl_6, none of the chlorine is ionic, *i.e.*, can be precipitated by silver nitrate.

The number of groups or atoms directly bound to the central atom (in the above cases) is 6; this is termed the "co-ordina-

tion number "—" a fundamental property of the elementary atom." This theory predicted and explained the existence of isomers, many of which have been since isolated. Where the co-ordination number is 6 the groups can be represented at the angles of a regular octahedron, thus:—



(Fig 19)

A recent writer has said: "It must be admitted that the conceptions used in Werner's theory, *e.g.*, those of 'supplementary valencies' and of the 'positions inside and outside the nucleus' are vague," and the author has, he believes, discovered an alternative method of explaining the formation of these complex molecules. Several compounds were examined with the object of finding out, whether, if p and p_1 are the rates of polymerisation of the component parts of a compound and A and B the percentage composition,

$$\frac{pA + p_1B}{100} = p_2,$$

where p_2 is the rate of polymerisation of the compound (see *The Chemical News*, 1921, CXXII., 3170).

Lead Sulphide.

	Temp. (A°)	p	
Pb	307	1.47	Calculated from specific heats.
S (rhombic)	304	1.83	
PbS	305	1.62	

	Percentage.	p.	p × %
Pb	86.6	1.47	127.3
S	13.3	1.83	24.3
			151.6

Average p = 1.516
Observed p = 1.62

$BaCl_2 . 2H_2O$.

$BaCl_2$	329	1.59	
$2H_2O$	273	3	(Considered as trihydrol)
$BaCl_2.2H_2O$	305	2.05	

	%	p	% x p
$BaCl_2$	85.2	1.59	135.5
$2H_2O$	14.8	3	44.4
			179.9

Average p = 1.8+ At 305°
Observed p = 2.05

$CuSO_4 . 5H_2O$.

	T	%	p	p x %
$CuSO_4$	335	63.8	2+	127.6+
$5H_2O$	273	36.2	3	108.6
				236.2

Average p = 2.36+
Observed p = 2.61 (335°)

$Mg(OH)_2$.

	T	%	p	p x %
MgO	335	71.4	2.01	143.5
H_2O	273	28.6	3	85.8
				229.3

Average p = 2.29
Observed p = 2.65 (at 308°).

The value of p for solid water is reckoned as 3 (its value at 273°), and so the average value of p would be lower in every case, and the disparity between the "average" and the "observed" values greater.

(*To be Continued.*)

THE LAW OF MAGNETIC ROTATION.

By Hawksworth Collins.

The magnetic rotation of an electropositive element, when in combination, is the product of half its atomic weight and the reciprocal of its relative volume.

The observation of this law rests not only upon the data given below, but also upon a very large number of facts arranged in a particular manner, which is called "The Correlation of Physico-Chemical Constants."

Earlier papers concerning the Heat of Formation of molecules were published in *The Chemical News* of August 18 and 25, 1922. The publication of the whole matter concerning these constants was commenced by *The Chemical News* on January 7, February 11 and 18, and August 19, 1921.

Table I. gives the relative volumes of the elements concerned. Table II. gives all available experimental results by Perkin in magnetic rotation; excluding compounds in which hydrogen occurs, for these cannot be included in a short paper. Table III. demonstrates the law.

TABLE I.

	Relative Volume.	Theor. S.G.	Obs. S.G. & Observer.
$CaCO_3$	13.25 + 20.55 = 33.8	$\frac{100}{33.8}$ = 2.959	2.938—2.995 Breithaupt
CaO	13.25 + 4.45 = 17.7	$\frac{56}{17.7}$ = 3.164	3.161 Karsten 3.18 Filhol
$CaCl_2$	13.25 + 2(15.085) = 43.42	$\frac{111}{43.42}$ = 2.56	2.48 Playfair & Joule
$CaBr_2$	12.24 + 2(23.09) = 58.42	$\frac{198}{58.42}$ = 3.39	3.32 11° Bodeker
CaS	12.24 + 15.53 = 27.77	$\frac{72}{27.77}$ = 2.59	2.58 Maskelyne
$BaCl_2$	24.0 + 2(15.085) = 54.17	$\frac{207}{54.17}$ = 3.82	3.82 Schiff
$BaBr_2$	24 + 2(23.09) = 70.18	$\frac{296}{70.18}$ = 4.22	4.23 Schiff
$CdCl_2$	14.57 + 2(15.085) = 44.74	$\frac{182}{44.74}$ = 4.07	4.05 25° Van Nostrand
$CdBr_2$	14.57 + 2(23.09) = 60.75	$\frac{271}{60.75}$ = 4.46	4.712 14° Bodeker
CdI_2	14.57 + 2(27.73) = 70.08	$\frac{365}{70.08}$ = 5.21	5.543 Kebler 4.576 10° Bodeker
CdO	15.16 + 2.51 = 17.67	$\frac{127}{17.67}$ = 7.19	8.11 Werther 6.95 Karsten
$CdSO_4$	15.16 + 15.53 + 2(7.53) + 2(2.51) = 50.77	$\frac{207}{50.77}$ = 4.08	4.447 Schroder
$SrCl_2$	23.96 + 2(15.085) = 54.13	$\frac{159}{54.13}$ = 2.94	2.960 Filhol 2.8033 Karsten
$SrCO_3$	19.56 + 20.55 = 40.11	$\frac{148}{40.11}$ = 3.69	3.68—3.714 Dana
SrI_2	19.56 + 2(27.73) = 75.02	$\frac{342}{75.02}$ = 4.56	4.55 25° Van Nostrand
$SrBr_2$	19.56 + 2(23.09) = 65.74	$\frac{248}{65.74}$ = 3.77	3.962 12° Bodeker

LiCl	6.21 + 15.085 = 21.295	$\frac{42.5}{21.295}$	= 1.996	1.998 Kremers
Li_2S	2(6.21) + 15.53 = 27.95	$\frac{46}{27.95}$	= 1.646	1.63—1.7 Van Nostrand
Li_2SO_4	2(6.21) + 15.53 + 2(7.53) + 2(2.51) = 48.03	$\frac{110}{48.03}$	= 2.29	2.21 15° Brauner
NaCl	11.85 + 15.085 = 26.935	$\frac{58.5}{26.935}$	= 2.17	2.17 20° Kaye & Laby
NaBr	11.85 + 23.09 = 34.94	$\frac{103}{34.94}$	= 2.95	2.952 Schiff
Na_2CO_3	2(11.85) + 20.55 = 44.25	$\frac{106}{44.25}$	= 2.40	2.407 Favre
NaI	11.85 + 27.73 = 39.58	$\frac{150}{39.58}$	= 3.79	3.654 18° Favre
KCl	22.29 + 15.085 = 37.375	$\frac{74.5}{37.375}$	= 1.994	1.994 Filhol
KBr	22.29 + 23.09 = 45.38	$\frac{119}{45.38}$	= 2.62	2.672 P & J 2.505 18° Spring
K_2SO_4	2(18.05) + 15.53 + 2(7.53) + 2(2.51) = 71.71	$\frac{174}{71.71}$	= 2.43	2.4073 Hassenf 2.572 Buiynet
K_2S	2(18.05) + 15.53 = 51.63	$\frac{110}{51.63}$	= 2.130	2.130 Filhol

TABLE II.

	Theoretical Magnetic Rotation.			M.R. by Perkin.
$CaCl_2$	1.51 + 2(3.932)	=	9.374	9.38
$CaBr_2$	1.635 + 2(7.95)	=	17.535	17.6
$BaCl_2$	2.833 + 2(3.932)	=	10.967	10.08
$BaBr_2$	2.833 + 2(7.95)	=	18.733	18.54
$CdCl_2$	3.81 + 2(3.932)	=	11.674	11.78
$CdBr_2$	3.81 + 2(7.95)	=	19.71	19.7
CdI_2	3.81 + 2(18.32)	=	40.45	40.8
$CdSO_4$	3.66 + 1.03 + 2(0.042) + 2(0.202)	=	5.178	5.17
$SrCl_2$	1.836 + 2(3.932)	=	9.7	9.7
$SrBr_2$	2.25 + 2(7.95)	=	18.15	18.16
LiCl	0.564 + 3.932	=	4.5	4.61
Li_2SO_4	2(0.564) + 1.03 + 2(0.042 + 0.202)	=	2.646	2.27
NaCl	0.97 + 3.932	=	4.902	5.068
NaBr	0.97 + 7.95	=	8.92	9.19
NaI	0.97 + 18.32	=	19.29	18.46
$NaCO_2CH_3$	0.97 + 2.299	=	3.269	3.281
$NaCO_2C_2H_5$	0.97 + 2.299 + (1.023)	=	4.292	4.308
$NaCO_2C_3H_7$	0.97 + 2.299 + 2(1.023)	=	5.315	5.332
KCl	1.749 + 3.932	=	5.681	5.66
KBr	1.749 + 7.95	=	9.699	9.36
KI	1.08 + 18.32	=	19.4	18.95
K_2SO_4	2(1.08) + 1.03 + 2(0.042 + 0.202)	=	3.678	3.57

$LiNO_3$ is the only other available compound. Its M.R. is given as "1.124 and

The experimental data for the magnetic rotation are always dependent upon the specific gravity. By employing a slightly different value from that which was probably used, the experimental figures can in nearly every case be brought exactly to the theoretical figures. For instance, the following are given as the S.G. of $BaCl_2$:—

3.82 Schiff
3.860—4.156 Boullay.

Suppose 4.056 *was employed as the* S.G. If 3.82 had been used instead, the result would have been

$$\frac{10.08 \times 4.056}{3.82} = 10.697$$

TABLE III.

Calcium.
$$\frac{40}{2 \times 13.25} = 1.51$$

Calcium.
$$\frac{40}{2 \times 12.24} = 1.635$$

Barium.
$$\frac{136}{2 \times 24} = 2.833$$

Cadmium.
$$\frac{111}{2 \times 14.57} = 3.81$$

Cadmium.
$$\frac{111}{2 \times 15.16} = 3.66$$

Strontium.
$$\frac{88}{2 \times 23.96} = 1.836$$

Strontium.
$$\frac{88}{2 \times 19.56} = 2.25$$

Lithium.
$$\frac{7}{2 \times 6.21} = 0.564$$

Sodium.
$$\frac{23}{2 \times 11.85} = 0.97$$

Potassium.
$$\frac{39}{2 \times 18.05} = 1.08$$

In addition to these results concerning electro-positive elements, the non-metallic element sulphur gives—

Sulphur.
$$\frac{32}{2 \times 15.53} = 1.03$$

and potassium gives another result, which differs from the others in not having its atomic weight halved:—

Potassium.
$$\frac{39}{22.29} = 1.749$$

If in the future any results similar to the last can be demonstrated, it will of course be evident that there is no discrepancy in *the matter, but that the exceptions only* lead to a deeper truth.

As the atomic numbers are sometimes *stated to be rather less than half the* atomic weights, it seems possible that with more accurate experimental data, the law may in the future be stated as follows:— "The magnetic rotation of an electro-positive element, when in combination, is the product of its atomic number and the reciprocal of its relative volume."

The two values 4.45 and 2.51 for oxygen, given in the relative volumes, are supported exactly by the Heats of Formation of the two substances CaO and CdO as published in *The Chemical News*, August 18, 1922.

A NEW METHOD OF DETECTING NICKEL IN SOLUTION.

By C. G. VERNON, B.A., B.Sc.

Concentrated ammonia in excess was added to the solution containing nickel, and hydrogen sulphide was passed through for a short time.

The solution was then boiled.

A *bright mirror* of metallic nickel was deposited, and its production was accompanied by a blackening of the solution.

This has been shown to occur even in very dilute solutions. If only a small trace of nickel was present the mirror took the form of an iridescent film.

Since the presence of cobalt does not affect it, the test is of some use in detecting nickel when mixed with cobalt. It may be introduced into the ordinary course of qualitative analysis by adding excess of strong ammonia before passing in hydrogen sulphide to precipitate the sulphides of the metals in the nickel group.

GENERAL NOTES.

GERMANY'S TRADE AND INDUSTRY IN FEBRUARY.

The Commercial Secretary at Berlin, Mr. J. W. F. Thelwall, has forwarded a report on the state of trade and industry during February.

The report states that in spite of the cutting off of the industrial west from the remainder of Germany, it has, in general, been possible to maintain industry in the Ruhr district and on the Rhine, as also in the rest of Germany. Ruhr coal, so far as not required within occupied territory, is being accumulated at the pit dumps and in the depots of the large works. The non-delivery of reparation coal to France and Belgium practically makes good the reduction of output which has naturally taken place since the occupation. Unoccupied Germany is helping itself by means of increased production and larger imports, above all, of English coal, so that the demand can be covered. It was endeavoured to make up for the shortage of pig iron, firstly, by an increased production of this material in Upper Silesia; finished iron was also delivered on a large scale thence, while the occupied territory had, to a large extent, to work on stock.

Potash.—In spite of the occupation of the Ruhr, the full maintenance of the potash industry was possible. Only comparatively small quantities of individual goods were stored. The sale of potash raw salts have, however, again fallen off as a result of increased railway freights, the latter already far exceeding the value of the goods. The call for by-products of the potash industry was only partially satisfactory; considerable quantities of sulphate of potash were, however, exported to the United States.

Aluminium.—In the Lüdenscheid aluminium and finished metal-goods industries, employment was bad, and the outlook for the future is not at all favourable. The industries are suffering from diminished foreign sales, and consequently the removal of the export duty and of foreign trade control is more than ever urgently desired.

Electrical Industry.—In the electrical industry the inland purchasing power is still weak. Neither official nor private customers dare place orders for large plant and machinery. Further, the partial fall of prices is causing some customers to hold back in the hope of further reductions. Foreign countries are, for the most part, showing reserve, in so far as the German prices, which have partly reached the world's market level and partly already exceeded it, admit of any competition. Accordingly a general falling off in orders is noticeable in high pressure current articles, machinery, apparatus, calculators, installation materials and cables. With regard to measuring instruments and electro-medical apparatus, the position is no better, owing to customers' loss of purchasing power. The outlook for railway safety appliances is bad. The sale of electric lamps at home and abroad shows no improvement.

Chemical Industry.—No details are available with regard to the chemical industry in the occupied territory. In general, however, it may be said that the chemical industry of the sonth portion of the occupied territory is suffering from a scarcity of coal. In the northern portion conditions are better. No restrictions of work have yet taken place. The hourly wage for unskilled workers is now 1,780 marks.

Glass Industry.—In the sheet glass industry very few inland orders were received. The general export figure remained unaltered. The works which deliver to the Russian border States lost practically their whole market as a result of cheaper offers from the Czecho-Slovakian glass industry. In the hollow-glass industry the supply of raw materials, with the exception of soda, was adequate.

Mining Industry.—The events in the Ruhr district accentuated the importance of Upper Silesian pit coal for the coal supply of the country. The Coal Commissioner of the Reich drew larger supplies of such coal for despatch to South Germany and Saxony, at the same time partly diverting Upper Silesian coal from the coastal districts, as these are better able to obtain supplies of English coal. Besides English coal, the import of coal from the Ostrau mines, which is particularly suitable for use in gasworks, has begun.

MEDICAMENTS FOR BULGARIA.

The Bulgarian Government invites tenders for adjudication on the 16th April for the supply of various medicaments, a list

of which is available for inspection at the Department of Overseas Trade by firms interested.

Local representation is essential. Firms desirous of tendering, but not locally represented, will be furnished upon application to the Department with the names of suitable firms.

OILS, PAINTS AND VARNISHES FOR EGYPT.

The British Commercial Agent for Egypt reports that the Egyptian Government invite tenders for the supply of oils, paints, and varnishes. Tenders close on the 17th April, and local representation is essential. The Department of Overseas Trade will be pleased to supply firms desiring to tender, not locally represented, with the names of some United Kingdom houses with Egyptian connections open to handle tenders on behalf of third parties.

Copies of the specification and conditions of tender are available for inspection at this Department (Room 53).

CZECHO-SLOVAKIA.

Demand for British Chemicals.

The Commercial Secretary at Prague (Mr. W. F. Vaughan Scott) reports that up to the present no falling off in the imports of chemicals from Germany has been noticeable, but there is no doubt that, owing to the rapid increase in prices of all German chemicals, and to the difficulty which importers anticipate experiencing in obtaining delivery of goods, an increased demand is likely to arise for the following British chemicals:—

Coal-tar and its derivatives.

Resin.

Cresines and petroleum jelly.

Refined yellow and white beeswax.

Oils for perfumes, soapmakers, and for medicinal purposes.

Pharmaceutical products.

Photographic chemicals.

Raw materials for the chemical industry.

The Commercial Secretary has also furnished (1) the names and addresses of agents who might suitably represent British firms of chemical manufacturers, and (2) a list of the most important Czecho-Slovak importers of chemicals. Copies of these lists may be obtained by interested United Kingdom firms upon application to the Department of Overseas Trade.

TRADE FAIRS.

Are Trade Fairs and Exhibitions Worth the Outlay?

Last week's *Manchester Guardian Commercial* states that much energy and money must have been wasted on fair schemes, energy which, if only directed by intelligence instead of imagination, might have produced real results. Trade fairs generally fall under one of two heads, *Direct Business* and *Propaganda*. Under the former fall, those attended principally by "the trade," and at which actual orders from trade buyers are expected, the attendance of the general public is neither invited nor encouraged. The remainder come under the heading of *Propaganda*. With certain notable exceptions, the possibility of immediate business diminishes in proportion to the attendance of a merely curious public. Many of them undoubtedly are good value for the money demanded, either in publicity, in direct business, or in both combined. Firms taking part in these may receive a good return on the money paid for the space occupied. Few firms have a considered and definite policy in regard to exhibitions. Like any other medium of trade, an exhibition should be the subject of a definite policy, and each proposal should receive due consideration.

INDIAN IMPORTS FROM APRIL TO DECEMBER, 1922.

Mr. T. M. Ainscough, O.B.E., H.M. Senior Trade Commissioner in India, draws attention to the following features:—

The total imports of merchandise for the nine months declined somewhat. Shipments from the United Kingdom declined, but the British share of the total rose from 56 per cent. to 61 per cent. The most striking feature has been the increase in the proportion of goods derived from Germany, from 2.4 per cent. to 5 per cent. There are good grounds for satisfaction that in a time of such depression the United Kingdom should be maintaining her position in the Indian import trade.

Dyestuffs obtained from Coal Tar.—The total trade fell from 207 to 189 lakhs. The British share was reduced from 58 to 15 lakhs, and that of America from 24 to 7 lakhs, but Germany, who once again controls this trade, increased her share from 92 to 146 lakhs.

Coal.—Although the total trade fell considerably, the reduction has mainly been in Natal, Portuguese East African, and Australian coal. The imports from the U.K. were reduced only slightly.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, MARCH 22, 1923.

Papers read:—

L. T. HOGBEN and F. R. WINTON. *The Pigmentary Effector System. III.—Colour Response in the Hypophysectomised Frog.* Communicated by Prof. E. W. MacBride, F.R.S.

H. R. SEWER. *Studies on Amphibian Colour Change.* Communicated by Prof. E. W. MacBride, F.R.S.

J. WALTON. *On Rhexoxylon, Bancroft. A Triassic Genus of Plants exhibiting a Liane-type of Vascular Organisation.* Communicated by Prof. A. C. Seward, F.R.S.

Papers read in title only:—

G. HEWETT. *The Dusuns of British North Borneo.* Communicated by W. B. Hardy, Sec. R.S.

M. TRIBE. *The Development of the Hepatic Venous System and the Postcaval Vein in the Marsupialia.* Communicated by Prof. J. P. Hill, F.R.S.

J. GRAY. *The Mechanism of Ciliary Movement. III.—The Effect of Temperature.* Communicated by Prof. J. S. Gardiner, F.R.S.

E. PONDER. *The Inhibitory Effect of Blood Serum on Hæmolysis.* Communicated by Sir E. Sharpey Schafer, F.R.S.

ROYAL MICROSCOPICAL SOCIETY.

The section of the Society which has been formed to deal with the Industrial Applications of the Microscope, and to assist in the development of Industrial Research in British Industries, held a meeting at 20, Hanover Square, W.1, on Wednesday, March 28.

Messrs. J. W. Atha & Co. exhibited the new Zeiss Photographic Eye-piece, "Phoku."

Mr. John H. Barton exhibited a new Research Microscope of original design.

Messrs. R. & J. Beck, Ltd., exhibited a microscope specially suitable for the examination of large surfaces of paper and of prints and engravings.

The Edison Swan Electric Co., Ltd., demonstrated the Ediswan Pointolite Lamp, 30, 100, 500 and 1,000 c.p. in operation. They also exhibited and explained the working of the alternating current Pointolite lamp.

Messrs. Ogilvy & Co. exhibited a new stereoscopic magnifier giving large field of view and long working distance.

Mr. Mansell P. Swift demonstrater Professor Shand's recording micrometer which is designed to facilitate the quantitative estimation of minerals in rocks.

Communications.

MR. J. LEONARD SPICER in the chair.

MR. JAMES STRACHAN, F.INST.P., F.R.M.S., *The Manufacture of Containers and Papers used for the wrapping of Foodstuffs.*

MR. HAROLD B. WRIGHTON, B.MET., F.R.M.S., *The Microscope in Metallurgical Research.*

MR. SYDNEY R. WYCHERLEY, F.R.M.S., *Microscopy in the Examination of Manufactured Paper.*

Future meetings, for which invitations may be obtained on application to the Secretary, will be held, as follows:—

April 18: Mr. D. W. CUTLER (Rothamsted Experimental Station), *The Protozoa of the Soil.*

May 16: Mr. LEONARD TAVERNER, A.R.S.M., *The Principles and Application of Technical Metallurgical Microscopy.*

Mr. W. M. AMES, M.A., B.Sc., A.I.C., *Applications of the Microscope in the Manufacture of Rubber.*

May 30: Mr. H. B. MILNER, *The Microscopical Investigation of Sands for various Industrial Purposes.*

Enquiry Bureau.

Enquiries have been already received relating to the following matters, and any information relating to them will be greatly appreciated:—

Examination of metals for making machinery.

Examination of crystal structure of fats.

Examination of powders of the same refractive index as Canada Balsam.

Examination of silk used in fine sieves.

How can thin oil deposits be examined with transmitted light in order to determine shape, distribution and thickness?

* How can one ascertain by means of the microscope the suitability of moulding

sand for producing fine surfaces on castings?

Wanted, a suitable method of cutting *sections of soap, and a suitable mounting* medium for the same.

What is the best method of testing mounting media for refractive index by *means of the Microscope?*

* This subject will be dealt with at the meeting on May 30.

MINERALOGICAL SOCIETY.

MARCH 13, 1923.

Dr. A. Hutchison, President, in the Chair.

DR. A. HUTCHISON. *A Graphical Method of correcting Specific Gravity Determinations.*

A diagram was given by which the correction for air displacement and reduction to 4° C. can be read off directly.

A. BRAMMALL and H. F. HARWOOD. *The Dartmoor Granite (Widecombe Area).*

Field evidence and analyses support the conclusion that the granite is a composite laccolite, and that four successive stages of intrusion are recorded by (1) dark and relatively basic granites scantily exposed and by certain cognate xenoliths resembling basic segregations; (2) a more acid granite which caps many tors and yields mineral evidence of having assimilated country rock; (3) a still more acid granite intrusion into the latter; (4) minor acid intrusions, felspars, garnet, cordierite, etc., were described, and evidence for differentiation was given.

C. E. TILLEY. *Genesis of Rhombic Pyroxene in Thermal Metamorphism; Mineral Associations and the Phase Rule.*

Free-silica hypersthene-bearing hornfelses of sedimentary origin can be divided into a calcic and non-calcic group, and considered as derived from a normal shale hornfels by increments either of CaO, (MgO + FeO), or less commonly K_2O. Silica-poor hypersthene hornfelses can be derived from the free-silica types and the hypersthene is then frequently accompanied by spinel. The derivation of all these hornfelses can be graphically expressed in systems of three or four components. The hypersthene is derived from the chlorite in the original sedimentary rocks subjected to metamorphism. Hypersthene arises when enstatite, augite, or amphibole-bearing igneous rocks enter contact aureoles, and examples of these are given. Reference is made to the production of rhombic pyroxene by contamination of gabbroic rocks. The hornfelses are considered from the standpoint of the phase rule, a classification considered, and the condition of equilibrium in the inner zone of hornfelses in contact aureoles discussed.

C. S. GARNETT. *On a peculiar chlorite-rock at Ible, Derbyshire.*

A band in the dolerite still at Ible is completely altered to a foliated mass of chlorite, with associated veins of fibrous chlorite (resembling chrysotile in appearance). The analyses and characters of this material are compared with those of "epi-chlorite."

C. S. GARNETT. *The Dissociation of Dolomite.*

The statement in the text-books that dolomite dissociates in two stages, giving when half-burnt a mixture of calcium carbonate and magnesia, is not confirmed. Dissociation is inappreciable up to 625°, and at 898° it is complete. The temperature-dissociation curve is continuous.

J. G. C. LEECH. *Occurrences of Rutile, Brookite, and Anatase in the St. Austell Granite.*

These minerals occur in the red pneumatolysed granites of the area, the mode of occurrence being essentially the same as that recorded for Dartmoor occurrences of those minerals.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The next meeting of the Society will be held on Wednesday, April 4, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., at 8 p.m. The following papers will be read:—

Physiological Standardisation, by DR. STANLEY WHITE.

An Investigation into the Chemistry of the Reinsch Test for Arsenic and Antimony, and its extension to Bismuth, by B. S. EVANS, M.B.E., M.C., B.Sc., F.I.C.

The Estimation of Boric Acid in "Liquid Eggs" and other Foodstuffs, by G. W. MONIER-WILLIAMS, M.A., PH.D., F.I.C.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The programme for the summer meeting at North-Western Centre, 5—8 June, will be as follows:—

Visits.

TUESDAY, JUNE 5.

Morning (*a*) The electrically driven rolling mill equipment of Messrs. R. Johnson and Nephew, Ltd., Bradford, Manchester, and the engineering works of Messrs. Mather and Platt, Ltd., Newton Heath; or (*b*) The No. 2 Dunlop Rubber Cotton Mills, Ltd., Rochdale.

Lunch at the Manchester Town Hall as the guests of the Corporation Electricity and Tramways Committees.

Afternoon (*c*) Messrs. Pilkington Tile & Pottery Co., Ltd. (makers of the Lancastrian art pottery); (*d*) The Chloride Electrical Storage Co., Ltd.; (*e*) The London, Midland and Scottish Railway Company's power station, and, at Ringley, (*f*) The Lancashire Electric Power Company's station.

WEDNESDAY, JUNE 6.

Morning.—Proceed at the invitation of the Manchester Ship Canal Co., Ltd., by special steamer from Pomona Docks, viewing the swing bridges and other engineering features en route, to Barton, where the party will disembark and inspect the Manchester Corporation's new generating station.

Lunch at Trafford Park as the guests of the Metropolitan-Vickers Electrical Co., Ltd.

Afternoon.—Visit the works of the Metropolitan-Vickers Electrical Co., Ltd., and the Lancashire Dynamo and Motor Co., Ltd., Trafford Park.

As alternatives to the foregoing visits, members may visit the following places at any time on Tuesday or Wednesday:

(1) The outdoor 33,000-volts sub-station (in High Street) of the Manchester Corporation; and

(2) The *Manchester Guardian* Offices, for the Murray Multiplex System of Telegraphy, and Rotary Printing Presses.

(3) *On Wednesday morning only*, the Laboratories of The University, Manchester, will be open for inspection.

THURSDAY, JUNE 7.

Alternative morning visits:—

(*a*) The British Insulated and Helsby Cable Works, Prescot.

(*b*) (1) The Liverpool Corporation Tramways, Lambeth Road Works.

(2) Automatic Sub-station, Walton.

(3) Lister Drive Power Station.

(*c*) The Cunard Company's s.s. *Scythia*, or some other big liner.

Alternative afternoon visits:—

(*d*) Messrs. Lever Bros., Port Sunlight.

(*e*) The University Applied Electricity Laboratories, where demonstrations in radio reception will be given, and The Automatic Telephone Manufacturing Co., Ltd.

(*f*) (If sufficient applicants):

(1) The Liverpool Corporation Tramways, Lambeth Road Works.

(2) Automatic Sub-station, Walton.

(3) Lister Drive Power Station.

Note—As other alternatives to the afternoon visits, members may also visit: (*g*) The Mersey Power Co., Runcorn (the company will arrange for tea and transport at Runcorn); (*h*) The United Alkali Company's Power Station, Widnes; (*i*) The London, Midland and Scottish Railway, Southport Electrified Line.

FRIDAY, JUNE 8.

Morning.—Leave Liverpool by special train for Llandudno Junction, where the party will transfer to motor coaches and proceed by alternative routes as follows:—

(*a*) Via Conway Valley, Bettws-y-Coed, Capel Curig, Llanberis or Nant Ffrancon Pass to Carnarvon and Bangor, returning along the coast road to Llandudno; a halt will be made at Dolgarrog to inspect the hydro-electric power station and works of the Aluminium Corporation, Ltd.

(*b*) Generally as (*a*) above, but the halt will be made at Pen-y-Gwryd to inspect the North Wales Power Company's hydro-electric station at Cwm Dyli.

(*c*) Generally as (*a*) above, but the halt will be made at Lord Penhryn's Slate Quarries, Bethesda.

A meeting was held on Thursday, March 22, when a discussion on papers by MR. FRANCIS HOOPER and MR. J. W. BEAUCHAMP, on the *Co-operation between the Architect and the Electrical Engineer*, was continued.

The January issue of the *Journal of the Chemical Society of Japan* contains the following papers communicated to the Society.

The Detection and Separation of Iridium, by ISABURO WADA and LUNAO ATO.

Uses of Amalgams in Volumetric Analyses, Part VIII. On the Determination of Chromium and of Iron Accom-

panying with Chromium, by NAOTSUNA KANO.

Uses of Amalgams in Volumetric Analyses, Part IX. On the Determination of Titanium and of Iron Accompanying with Titanium, by NAOTSUNA KANO.

On the Nitrogenous Compounds in the Flesh of Mactra sulcataria, Desh, by KIYOHISA YOSHIMURA.

On the Nutritive Value of the Proteins of Soy Bean and Pea Nut, by TOKITAKA SHIBA and MANSHI KOYAMA.

On the Protein of Rice Embryo and its Nutritive Value, by MATSUKICHIRO HAMADA.

Preparation of Petroleum from Fatty Oils, Part II., by MASAKAZU INONYE.

CORRESPONDENCE.

THE TITLE, "CHEMIST."

To the Editor of THE CHEMICAL NEWS.

SIR,—The Retail Pharmacists' Union, in their recent announcement with regard to the subject of the accurate dispensing of medicines have, I think it will be generally agreed, made a good statement on behalf of the profession of pharmacy.

I would, however, venture to place before your readers a matter, arising from the above, which is one of no small concern to those chemists who are engaged in the practice of *Chemistry* as distinct from *Pharmacy*—that is to say, who are concerned with the science of chemistry and its applications to the arts and manufactures, and have nothing to do with the dispensing of medicines.

The Retail Pharmacists' Union have headed their announcement with the words "*The Chemist*," and I would like to make, in the public Press, the suggestion which has so often been made in the scientific Press, that the time has come for the pharmacist to relinquish the use of the term "chemist" in favour of those who definitely practise chemistry.

The war was instrumental in directing the attention of the public more closely to the existence of the profession of chemistry, the profession on which the country found it necessary to rely or the production of explosives and materials of war generally, as well as for the means of protecting our troops against the methods of chemical warfare initiated by the enemy.

During the past half-century, the science of chemistry has developed by leaps and bounds, and its practice as a profession has become more and more firmly established. In this country the science is now taught in 1,000 or more public and secondary schools, and in nearly 300 technical schools, while our University Departments of Chemistry are renowned throughout the world.

The Institute of Chemistry, as the representative Chartered professional body of chemists, numbers upwards of 4,000 Fellows and Associates, whose qualification demands a four years' University course, or the equivalent, and the majority of whom are engaged in the many branches of industry on which the science has a bearing.

In other countries, the strict equivalent of the word "chemist" signifies, as it should, one who professes chemistry, and not in any case the pharmacist, druggist, or dispenser of medicines. How the misapplication of the word has arisen in this country is a matter which I need not here pursue. The enormous importance of chemistry is becoming daily more widely recognised, and it is highly desirable in order to avoid confusion, that the word "Chemist" should be confined to those who practise chemistry in the full sense of the word. It is bad enough when mental confusion is the unfortunate consequence of the poverty of a language, but in this instance the correct and distinctive words are ready to our hand.

I would like to express the hope which I have already expressed on a good many occasions, that our friends the Pharmacists —notwithstanding the provision of the Pharmacy Act—will lose no opportunity of referring to their ancient and important calling by the word which more accurately defines and describes it. In addition, I would appeal to the Press, which is so important a factor in the enlightenment of the general public, to assist so far as they can by employing the terms "Chemist" and "Pharmacist" respectively in their obviously correct significations, so that those practising chemistry may be described as Chemists, and those practising pharmacy as Pharmacists.—Yours, &c.,

A. CHASTON CHAPMAN, *F.R.S.*,
President of the Institute of Chemistry of Great Britain and Ireland.

30, *Russell Square, London, W.C.*
March 17, 1923.

NOTICES OF BOOKS.

The Chemist's Year Book, 1923. Edited by F. W. ATACK, M.Sc. (TECH.), D.Sc., F.I.C., assisted by L. WHINYATES, A.M.C.T., A.I.C. In two volumes. Pp. VII. + 1,108. Manchester: Sherratt & Hughes, 34, Cross Street. 1923. 21s. 9d., post free (abroad 22s.).

English-speaking chemists have for several years had the opportunity of possessing a volume (or rather two) convenient for the pocket and containing an enormous amount of information such as is frequently needed in the ordinary course of their work. That this is the 8th edition is sufficient testimony to indicate how much the *Chemist's Year Book* is appreciated.

In this edition a new section on Leather Analysis, by W. Mather, A.M.S.T., A.I.C., has been incorporated. Various sections have been revised and corrected where necessary, in accordance with the results of the most recent researches.

The Chemist's Year Book for 1923 should thus prove as popular among chemists as its predecessors have been.

J.G.F.D.

Vat Colours, by JOCELYN FIELD THORPE, D.Sc., PH.D., F.I.C., F.R.S., and CHRISTOPHER KELK INGOLD, D.Sc. Pp. XV. + 491. London: Longmans, Green & Co., 39, Paternoster Row, E.C.4. 1923. 16s. net.

It has long been recognised that fast colours can only be imparted to fabrics by forming the coloured compound within the fibres of the material to be dyed.

The vat dyes include chemically very dissimilar types such as indigo, indanthrene and indophenol. The essential feature is that the substance must possess a carbonyl group, capable of being reduced to the group C·OH, forming a lenco-compound, soluble in alkalis.

The vat colours are usually insoluble in ordinary solvents, and are applied in the form of colourless and soluble reduction products.

Re-oxidation by exposure to air develops the original colour within the fibre.

Of the vat dyes, the "Purple of the Ancients," and especially Indigo, were known to the earliest dyers, and the authors have rightly devoted adequate and careful attention to the history of these colours. Indigo was, until the last few decades, the only vat dye of commercial importance.

Baeyer's extensive researches, and also those of other German chemists which led to the elucidation of its structure, were followed by various syntheses of indigo itself, and subsequently by the preparation of similar dyestuffs of different shades.

These syntheses also revealed the essential structure of the vat dyes, and more recently, important new types of these compounds have been produced from anthraquinone. The authors give a complete account of these bodies, some of which are very complex, and whose molecules contain many condensed rings.

The last section of this very complete monograph gives detailed instructions for the preparation of the dyes themselves, and also their intermediate products.

An appendix gives a list of British vat dyes and their German equivalents.

The monograph will be of great service to chemists and others engaged in the dye industry, since it is the only volume dealing exclusively and comprehensively with this class of dyes. It will also be widely consulted by the general scientific world

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Back to Prosperity, by HENRY LOWENFELD and his daughter, MARGARET LOWENFELD. Pp. 268 + XII. London: Effingham Wilson, 16, Copthall Avenue, E.C.2. 1923. 5s.

This very original volume on the intricacies of monetary systems and present anomalies arising from the chaotic state of foreign exchanges, should prove of interest and importance to those connected with the financial side of chemical and other businesses.

BOOKS RECEIVED.

Atoms, by JEAN PERRIN, translated by D. H. HAMMICK, M.A. Pp. XIV. + 231. Second English Edition. 1923. Messrs. Constable & Co., Ltd., 10 & 12, Orange St., Leicester Square, W.C.2. 8s. 6d. net.

Readable School Chemistry: A Book for Beginners, by J. A. COCHRANE, B.Sc. Pp. IX. + 84. 1923. Messrs. G. Bell & Sons,

Ltd., York House, Portugal Street, W.C.2. 2s.

The Generation and Utilisation of Cold: A General Discussion, by THE FARADAY SOCIETY. Pp. 137, 141 + 273. 1923. The Faraday Society, 10, Essex Street, Strand, W.C.2. 10s. 6d. net.

A Tested Method of Laboratory Organisation, by SEYMORE PILE, M.A., and REGINALD G. JOHNSTON, with an Introduction by W. R. BARCLAY, O.B.E. Pp. IX. + 98. 1923. Messrs. H. F. & G. Witherby, 326, High Holborn, W.C. 7s. 6d. net.

The Destructive Distillation of Wood, by H. M. BUNBURY, M.Sc. (Bris.), B.Sc. (Lond.). Pp. XIX. + 328. 1923. Messrs. Benn Brothers, Ltd., 8, Bouverie Street, E.C.4. 35s. net.

New Patents.

THIS list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

5699—Amber Size & Chemical Co., Ltd.—Production of aluminium hydroxide and alkali silicates. Feb. 27.

5716—Ashcroft, E. A.—Apparatus for electrolysing fused salts of metals and recovering metals and acid radicles. Feb. 27.

5576—Boudett, A. E. P.—Reduction of calcium sulphate. Feb. 26.

5856—Coley, H. E.—Extraction of gold from arsenical ores. Feb. 28.

5894—Dutt, E. E.—Preparation of manganese dioxide. March 1.

5746—Harnist, C.—Manufacture of fertilisers from sulphur. Feb. 27.

6015—Pinel, A.—Ripening alkali cellulose for manufacture of cellulose xanthate. March 1.

6016—Poma, G.—Manufacture of p-amino-phenol. March 1.

5877—Royston, G.—Drying sulphate of ammonia. March 1.

5877—Saville, W.—Drying sulphate of ammonia. Feb. 28.

6235—Standard Development Co.—Dehydrating alcohol. March 3.

Specifications Published this Week.

193071—Plauson's Parent Co., Ltd. (Plauson, Dr. H.)—Process of producing lower boiling hydrocarbons from high-boiling hydrocarbons.

176779—Norsk Hydro-Elektrisk Kvaelstof-aktieselskab.—Process for the manufacture of hydrogen, carbonic oxide or mixtures of these gases.

193304—Quinan, K. B.—Manufacture of superphosphate.

193477—O'Shaugnessy, F. R.—Method of and apparatus for the de-colloiding of colloidal organic matter, and the destruction of the offensive character of putrescible organic matter.

193551—Chemische Fabrik auf Actien (vorm E. Syhering).—Process for solidifying formic aldehyde.

193618—British Dyestuffs Corporation, Ltd., and Perkin, W. H., and Clemo, G. R.—Manufacture of a new chloroethyl-ester and the treatment of phenols, alcohols, and amino-compounds therewith.

193789—Casale, Dr. L., and Leprestre, R.—Apparatus for the catalytic synthesis of ammonia.

Abstract Published this Week.

191687—Ferrocyanides.—Silver Springs Bleaching and Dyeing Co., Ltd., and Hall, A. J., Timberbrook, Congleton, Cheshire.

The waste liquor from aniline black dyeing in which ferrocyanide is used, is treated with ferrous sulphate so as to obtain a blue precipitate as described in the parent case, and the blue precipitate is separated and dissolved by means of an alkali, alkaline earth, or ammonia. The iron hydrate also produced is separated from the solution and the ferrocyanide is obtained by crystallisation from the filtrate.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the price of 1s. 6d. each

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3286.

THE STYLE OF SCIENTIFIC LITERATURE.

"What one fool can do, another can."

This sweeping assertion is to be found on one of the fly-pages of the late Professor Silvanus P. Thompson's book, *Calculus Made Easy*. The assertion is rather significant, and we should hesitate to contradict it, but a great moral lies in the words.

At the time when Professor Thompson wrote the book in question, he probably held pronounced views upon how Science should be regarded, and gives one the impression that he looked upon it as a huge joke, not to be inconsiderately thrust aside, but to give food for deep reflection.

Whatever may be the attitude of the student of Science to his subject, the writing of a scientific book is, essentially, a teaching process, whether it be an elementary text-book or an exposition upon some greatly obscure discovery. Yet how often has a chemist sat down in the evening with a pile of laboratory results before him, almost groaning with vexation because the works of reference he must of necessity use are tedious and prolix? They contain the information he requires, but he is only able to find it by much wading through a hideous sequence of almost incomprehensible words. Incoherency of text often worries him still more.

One can learn more in ten minutes from a book of the type Professor Thompson has written than from three hundred pages of unrelieved letterpress in several hours, and this is not an hyperbolic assertion by any means. One is interesting in itself; the other is not, but only in the matter it contains. We do not maintain that every book of scientific tendencies should be compiled similarly, for it would be an impossible expectation; but if the compilation was less elaborate, it would save the research chemist much valuable time. The exact difference is in writing what one may have to write within 200 pp. of large, widely-spaced print, and putting down precisely the same information in double the page-quantity of small print.

The matter has been discussed widely before now. Present conditions make fresh comments desirable. Formerly, admission to the learned professions was made only *via* the Universities; now, it is purely a question of initiative on the part of those who have not the means of studying at the higher educational centres. They must gain their knowledge mainly from books, and simplification is, to them, desirable.

VALENCY.

By William R. Fielding, M.A., M.Sc. (Vict.).

Senior Science Master, King Edward VII. School, Lytham.

(*Continued from Page* 197.)

All these compounds are exothermic, *i.e.*, as the energy of the system is reduced, p is increased, and we may safely predict that as heat is absorbed p is reduced.

When an exothermic compound is heated p is reduced; as a substance is cooled p is increased — again showing that as the energy of a system is increased p is reduced whereas as heat is taken out of a system the substance, either element or compound, becomes more polymerised. The maximum of polymerisation occurs at the absolute zero (see *The Chemical News*, Vol. CXXIII p. 97).

The halide acids illustrate this well, for the gaseous state.

	Heat of formation.
HF	+ 38,500 cals.
HCl	+ 22,000
HBr	+ 8,440
HI	- 6,040

Hydrofluoric acid is undoubtedly polymerised at 300° A. (H_2F_2) and is H_xF_x (where $x > 2$) at still lower temperatures. On the other hand, HI is endothermic, and it is not only less disposed to polymerise, but it is readily decomposed into its constituents. There is a kind of law of direct self-preservation—the more energy leaving the system and the more organised (p) does the system become. There seems grounds for believing that the different valency-values obtained by the different methods may be due in part to ignoring these charges in the energy of the system.

It is this variable quantity of energy which appears as heat-energy one moment and polymerisation another which accounts

for the many inexplicable exceptions to our preconceived valency-values.

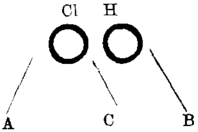
	Latent Heat.	p.	Heat absorbed.
Ice	80	3	↓
Water .		<2	
Steam .	537	1	

Data respecting endothermic compounds are not very abundant, but for

	T	p
CS_2 (Liquid)	243	1.88
	273	1.88
	303	[illegible]

(see *The Chemical News*, CXXII., 289).

An atom of hydrogen consists of a positive nucleus and one (negative) electron. As the temperature is raised the tendency to polymerise with other hydrogen atoms is reduced; so is the density; therefore the atomic volume is increased. This may be due to the electron increasing its distance from the + nucleus. If in combination with a chlorine atom, the hydrogen atom will tend to be electro-negative on the chlorine side and electro-positive on the side remote from the chlorine. If the electron enters the chlorine atom, or if it is only supposed to come to the "point of contact" or be the "point of contact" of the two atoms, there will be a readjustment of the electrical forces within the two atoms (Fig. XX.):



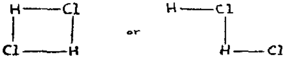
(Fig. 20.)

A.—Owing to the acceptance of electron from hydrogen there will be a disturbance in the orbits of at least some of the electrons of the chlorine atom. This side of the chlorine becomes electro-negative.

B.—This side becomes electro-positive.

C.—The electron accepted by the chlorine from the hydrogen.

Hydrochloric acid may become polymerised thus:—



(Fig 21)

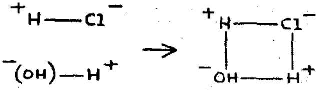
From the study of radio-active substances it is accepted that existing atoms have a positive nucleus and negative electrons. Are there, or have there been, any atoms with a negative nucleus and positive electrons?

Such a supposition would readily account for all combinations, except possibly in the case of the amphoteric elements. Consider the union of hydrogen and chlorine, an electro-positive nucleus in the former case and an electro-negative nucleus in the latter. Union is caused by a + electron from the chlorine neutralising an electron of the opposite sign from the hydrogen. (On separating the two atoms, the equal and oppositely charged electrons are restored to their original positions in the respective atoms.) The hydrogen part of the hydrochloric acid molecule would be electro +, and as in the former case may be able to effect combination with an electronegative element other than the chlorine with which it is already combined. Through the loss of one of its + electrons the chlorine is electro-negative and likewise may be able to effect combination with an electro + atom or radicle. Even the amphoteric elements need not offer serious trouble. We have to account for the combination of two electro-positive atoms in the molecule in H_2, and of two electro-negative atoms in Cl_2. In such cases the union may be effecteo by the + nucleus in one atom attracting the electron in the other atom thus:

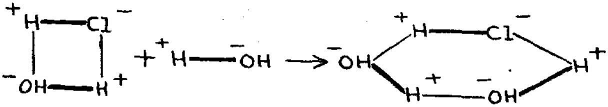
+ e

e +

Hydrochloric acid forms several well-defined hydrates, e.g., $HCl.H_2O$ and $HCl.2H_2O$. How do the acid and water combine? The signs opposite the symbols indicate whether the atom is electro-positive or negative. It is presumed, for the reasons given above, that combination with an atom or group of opposite sign may, in certain circumstances be effected (Figs. XXII. and XXIII.):



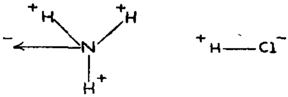
(Fig 22)



(Fig 23)

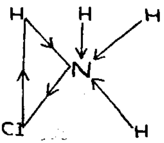
The thickened lines in Fig. XXIII. show the position of the main, principal or dominant valency.

Ammonium chloride may be derived in the same way from ammonia and hydrochloric acid, as in Fig. XXIV.:



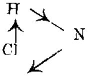
(Fig 24)

Nitrogen is slightly more than trivalent towards hydrogen, [illegible] not tetravalent, but the hydrogen and chlorine of the hydrochloric acid, approaching it at the same time, make it appear to be pentavalent, the chlorine partially returning the electron it has received from the hydrogen, which now becomes slightly electro-positive towards *the nitrogen which is now in a position to* transfer (partially) an electron to the chlorine. The return of the electron from the chlorine to the hydrogen, and from the hydrogen to the nitrogen, and lastly from t nitrogen to the chlorine, may not be completed but by readjustments in their electronic orbits these three elements are in equilibrium. Ammonium chloride would be represented as in Fig. XXV., the arrows showing the direction in which the electrons tend to be transferred.



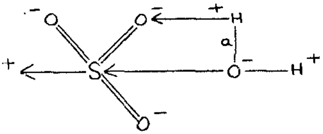
(Fig 25)

Unlike many rings, the ring



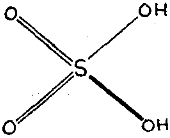
is easily ionisable in the presence of water.

Sulphuric Acid.—Here sulphur is electro-positive to oxygen (Fig. XXVI.):



(Fig 26)

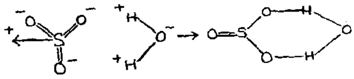
The water combines with the SO_3 one hydrogen joining on to an oxygen and the oxygen in the water directly linking with the central atom, sulphur. There is then a redistribution of valency as there are now four atoms or groups joined to the sulphur, with the result that valency *a* disappears. This is an exothermic action, and part of the heat evolved may be due to the rearrangement of the valencies.



(Fig 27)

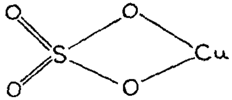
Fig. XXVII. shows the dibasic nature of the acid, whereas an alternative method of

linkages (Fig. XXVIII.) would lead to the formation of a closed ring which are often unionisable.



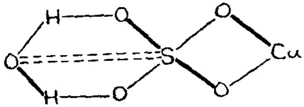
(Fig 28)

Fig. 28 may represent a temporary isomeric form which passes into the compound represented by Fig. 27 by the oxygen atom at the extreme right joining on to the sulphur. The former arrangement is to be preferred, not only because the valencies are the usual valencies of these elements, but because it shows the formation of the sulphates in a more straightforward way, thus:—



(Fig 29)

Sulphuric acid and the sulphates form hydrates, and the first molecule of water seems to occupy a unique position, and is more difficult to drive off than the other molecules of water. For this reason the following formula is given:



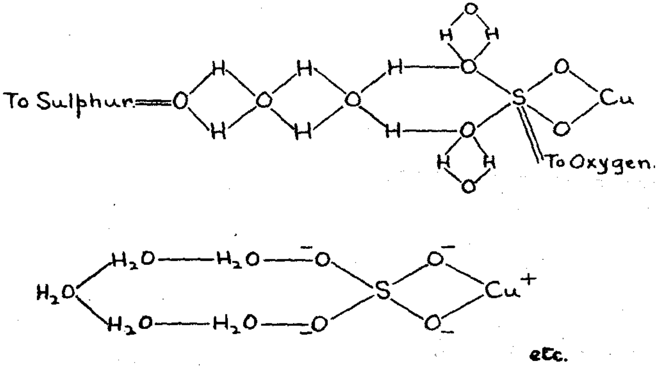
(Fig 30)

Four other molecules of water can be added, thus:

(See Fig. 31.)

Many rings are non-ionisable, but a solution of copper sulphate is readily precipitated by a solution of $BaCl_2$; evidently the above rings are very unstable in aqueous solution.

A few examples of non-ionisable rings will now be given.



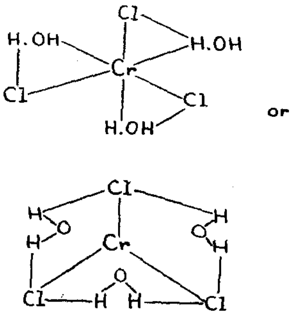
(Fig 31)

Chromium trichloride. — Three crystalline hydrates are known, $CrCl_3.6H_2O$, two green and one violet. Werner represented these as follows:

$$[Cr\ (OH_2)_4\ Cl_2]\ Cl\ +\ 2\ H_2O$$
$$[Cr\ (OH_2)_5\ Cl]\ Cl_2\ +\ H_2O$$
$$[Cr\ (OH_2)_6]\ Cl_3$$

The chlorine outside the square brackets is ionic.

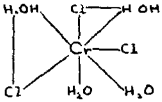
I prefer to think that the anhydrous chloride combines with three molecules of water and forms three closed rings, thus:



(Fig 32)

None of the chlorine is ionic. The chromium appears to be hexad. Considering one ring (1st formula), the chlorine receives an electron from the chromium, and with it it compensates the hydrogen to which it is directly attached, and enables it to hold the OH group and also to link up the chromium.

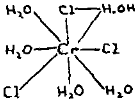
If another molecule of water is added to the molecule it breaks up the first ring and the chlorine which is freed becomes ionic (Fig. XXXIII.):



One-third of the chlorine is ionic.

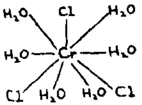
(Fig 33)

The second and third rings are broken up by successive molecules of water:



Two-thirds of the chlorine is ionic.

(Fig 34)

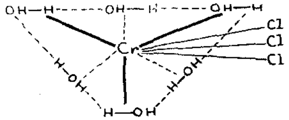


All of the chlorine is ionic. (Violet form.)

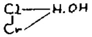
An alternative method would be to link the water and chlorine as in the second formula. The final form is the same in each case.

Thus chromium is attached by principal and subsidiary valencies to 6, 7, 8, *or* 9 atoms or groups. Six of these are water molecules in the last case and undoubtedly these water molecules will exercise valency towards each other to form polymers similar to di- and tri- hydrol in liquid and solid water. In any cases the valencies usually given to chromium cannot hold, because if these six molecules had a single resultant residual valency towards the nuclear chromium atom the valency of the latter would be 4. To mark the valencies between the chromium and the chlorine and to ignore the molecules which are included in the complex ion is simply shelving the matter. The heat change accompanying every chemical and physical change effects a change in the energy of the system, and the valency of any and every atom will be altered in some degree. There is no valid *argument against hydrogen becoming dyad* or triad and oxygen pentad. The weight carried by a person depends, to some extent, on the distribution of the load. The following seems to be the simplest way of

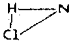
representing the complex ion, the dotted lines showing the weak valencies (**Fig. XXXV.**):



Thus the



ring is non-ionisable, whereas the unstable ring present in ammonium chloride is:—



(Fig 35)

(To be continued.)

COMPOUNDS OF SODIUM CARBONATE WITH FATTY ACIDS.

By J. F. Weinberg.

[*Editorial Note.* — This communication was sent under seal to the late Sir William Crookes, F.R.S., on December 26, 1919. Recently, efforts to get into touch with the author have failed. The seals were thereupon broken, and the article is now published.]

Preparation.

Fatty acids in a melted state readily combine with crystallised sodium carbonate (10 ag.) when melted in its water of crystallisation. A series of compounds is formed of a chemical character, much resembling sodium *bicarbonate*, its composition being represented by the formula:

$$Na_2H_2 \begin{matrix} CO_3 \\ (C_nH_{n-1}OO)_2 \end{matrix} \quad x\ H_2O$$

Properties.

These compounds can with great advantage be used instead of soap.

The effect on the skin is milder, no caustic soda being present or set free by hydrolysis.

The effect during ablutions is very remarkable.

The exudation from the human skin is a solution of organic nitrogen compounds in volatile fatty acids.

In foul linen these volatile fatty acids are soon evaporated, leaving a residue insoluble in caustic soda and insoluble in soap.

Therefore, soap will never make foul linen clean, scrubbing and bleaching agents being indispensable.

However, this residue is easily soluble in a hot aqueous solution of the above-mentioned compounds. It is also soluble in hot dilute hydrochloric acid (0.1 per cent.), which seems to account for the action of chlorine in the presence of moisture.

Boiling for half an hour in a 1-2 per cent. aqueous solution of the compounds just described, will clean the foulest linen, mechanical treatment as well as bleaching agents being altogether superfluous.

Preparation on a Large Scale.

The fat to be used is saponified, then decomposed by sulphuric or hydrochloric acid. Any other process may likewise be used to obtain the fatty acids.

The fatty acids are simply melted, and in this state added to sodium carbonate (10 H_2O) melted in its water of crystallisation.

When the mixture is stirred, the reaction is complete. No carbonic acid is set free, all of the water of crystallisation may remain in the product.

Fatty acids prepared from Sunlight soap (the melting-point of the acids was 27° C.) give a product of very much the same appearance, only being a little harder.

The proper proportions are approximately: 1 part of fatty acids to ½ part of carbonate of soda (10 H_2O). However, an excess of carbonate of soda seems advisable. Good results were obtained with: 1 part of carbonate of soda, 1 part of fatty acids.

CONCENTRATED BORATE OF LIME.

By E. L. Fleming.

Crude borate of lime contains 28.2 per cent. anhydrous boracic acid. Its value delivered, at 7s. 3d. per unit, is £10 5s. per ton, which does not pay cost of collection and transport. If it is dried and contains 43 per cent. A.B.A. its value delivered is £15 13s. per ton.

By removing 63 per cent. of the worthless material associated with the borate of lime, freshly drawn from the deposit, a concentrated borate is produced containing

75 per cent. A.B.A., and its value delivered is £27 6s. per ton. The process s quite simple, the materials used for its production being products of the countries where the borate of lime is located. The approximate cost of production at the Boratera, for one ton of concentrated borate, working with the smallest plant, with an output of 300 tons per ann. being £12 per ton. It may be worked with unskilled native labour. The plant for producing concentrated borate can be obtained from a well-known firm of chemical engineers in England.

The advantages possessed by concentrated borate 75 per cent. A.B.A. are that by boiling it with half its weight of 58 per cent. alkali, it produces 200 per cent. of its weight in crystal borax. The solid refuse only amounts to 7 per cent. There is a saving of 42 per cent. in transport, when compared with calcined borate 44 per cent. anhydrous boracic acid.

In Argentina, borate of lime ground covering an area of 76,000 hectares has been recorded in the State Mining Roll. The level at which these borateras are located is reached by the Central Northern Railway, at Tres Cruces. In Bolivia, by the Arica-la Paz Railway at Charana. In Chile, by the Antofagasta and Bolivian Railway at Ascotan. In Peru, by the Arequipa Railway at Pampa de Arrieros.

The borate of lime occurs in three distinct formations:

(1) In layers on the surface of the ground.

(2) In banks, five or six feet in depth.

(3) In the form of "potatoes" or rounded masses, scattered throughout the soil.

ACTIVE HYDROGEN: NEW METHODS OF PREPARATION.

By Y. Venkatramaiah.

Continuing his researches on the activation of hydrogen, the author has elaborated four more new methods of activating the gas. The new methods are:

(*a*) The burning of oxygen in hydrogen. —The hydrogen and oxygen utilised in all the experiments conducted was prepared by electrolysing a solution of barium hydroxide. The gases were purified and dried in the usual way.

The combustion of oxygen and hydrogen was carried out in a specially constructed apparatus kept cool at 0° C. The combustion tube was of platinum, of 12 mm. internal diameter. The oxygen flame was nearly six inches in height. The unburnt hydrogen was drawn out through a tube kept in iced water, on to cold powdered sulphur, and the presence of hydrogen sulphide was tested by using a lead acetate paper.

(*b*) The surface combustion of hydrogen and oxygen on platinum.—In this experiment a platinum wire 3 metres in length aud 0.4 mm. in diameter was wound round a glass rod frame 10 cm. in breadth and 12 cm. in length. The wire was electrically heated by placing the frame in a suitable apparatus into which a proper mixture of oxygen and hydrogen could be introduced containing slight excess of the latter. The presence of activated hydrogen in the uncombined gas was recognised in the usual way.

(*c*) High tension arc in hydrogen. — A high tension arc was established between two silver electrodes 5 mm. in diameter. The electrodes were kept 1½ cm. apart. A large induction coil whose primary could be fed with a current up to 20 amperes was used along with a Wehnelt interrupter. The presence of active hydrogen in the gas drawn out was tested in the usual manner.

(*d*) High temperature arc in hydrogen.—In this case hydrogen was conducted into arcs established between metallic electrodes 1 cm. in diameter, of gold, platinum, and silver fixed in a suitable apparatus. The electrodes were kept fed with a current of 6 amperes under 220 volts pressure. The presence of the active gas in the hydrogen drawn out from the arcs was tested as previously described. In the case of silver, activation of hydrogen was possible, while in the case of gold and platinum it was not. An explanation for this discrepancy seems to be in the absorption of active hydrogen by thin films of metals in the case of gold and platinum which are known to absorb larger quantities of hydrogen than silver itself.—(From the *Proceedings of the Science Association*, Maharajah's College, Vizianagram, Dec., 1922.)

COMPRESSIBILITY, INTERNAL PRESSURE, AND ATOMIC MAGNITUDES.

By Theodore W. Richards.

The contraction of elements in the formation of compounds has been evaluated

from the determined compressibilities of the individual elements.

In the pressure-volume curves for sodium and potassium, which extend over a range of 45,000 atmospheres, considerable identity with Bridgeman's values (*Proc. Am. Acad. Arts Sci.*, 1922, LVIII.) is disclosed, and the assumption that they are more or less accurate is justifiable. The extant irregularities are considered due to the volume, rather than the pressure or the two together, and the ultimate pressure is computed as the sum of internal and external, giving an equation of the type: $(p+P) f v = K$; where p = the external, and P = the initial internal pressure. A close study into the curves revealed a formula notable for its simplicity: $(V-B)(p+P) = K$. According to this, the B portion acts as if it were incompressible, and "the relation of the total pressure (external plus internal) to volume is simply hyperbolic. Tabulation of the K-volumes shows similarity between the calculated and observed values of V.

The curve seems to have bearing upon the contraction which occurs when potassium and chlorine combine to form potassium chloride. The sum of the gram-atoms of these elements is 70.5 cc., and the reduction takes place over a range of 33.0 cc., the final volume being 37.5 cc. The range of compressibility of chlorine is nearly that of potassium; thus, if potassium at 44,000 atmospheres is reduced to half its original volume, the average P of potassium chloride is of the same order.

As separate from monatomic molecules, polyatomic molecules demand recognition of the fact that two or more internal pressures must exist; those caused by chemical affinity and those due to material cohesion. The polyatomic curve, then, will be complex; one with a hyperbola similar to that of K, and the other almost horizontal, corresponding to the greater pressure in certain parts of the atoms. The two curves may be roughly depicted by one hyperbola.

Phosphorus trichloride presents an instance. The behaviour of a millilitre as far as 12,000 atmospheres conforms to the equation $(p+6200)(V-0.67) = 2050$; the large value of B corresponding to unit initial volume.

There has been no first-hand data computed for chlorine, as the subjection of this element to high pressures is difficult in modern apparatus. Some figures were obtained, however, which admitted of plausible calculations over the chloride range. The contentions are based upon observance of the respective compressibilities of chloroform and carbon tetrachloride, and by comparing chloroform with bromoform (Richards and Stull; *Carnegie Inst. Pub.*; 1903, VII., 44). The comparison rendered the indicative equation:—

$$\beta_{Cl} = \beta_{CHCl_3} \times \frac{\beta_{Br}}{\beta_{CHBr_3}}$$

this conclusion being drawn from the fact that the differences between the boiling points of chlorine and bromine, and the two derivatives mentioned, are approximately identical.

Phosphorus trichloride seems to throw some light upon the problem. The compound contains rather over ¾ of its weight of chlorine, and the phosphorus must obviously be compressed to a smaller bulk than either white or red phosphorus. A study of the two volumes shows that the chlorine is in a similar condition to independent liquid chlorine. From these inferences, a curve depicting the behaviour of liquid chlorine may be obtained; it being confirmed by the compressibilities of both bromine and iodine.

The numerous data comply invariably with observations contained in an earlier communication; but the modified principles clarify to a considerable extent the curious actions of many solids and liquids, and further discussion upon some of them will follow in the near future.

[Substance of a Contribution from the Wilcott Gibbs Memorial Laboratory of Havard University; quoted from the *Journ. Amer. Chem. Soc.*, 1923, XLV., 422.]

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY OF ARTS.

INDIAN SECTION.

Friday, April 6th, 1923, at 4 p.m.
Postal and Telegraph Work in India, by GEOFFREY ROTHE CLARKE, ESQ., C.S.I. O.B.E., I.C.S., Director-General of Posts and Telegraphs in India.

The Right Hon. Lord Montagu of Beaulieu, K.C.I.E., C.S.I., will preside.

SOCIETY OF GLASS TECHNOLOGY.

The President, Prof. W. E. S. Turner, D.Sc., presided at the meeting of the Society of Glass Technology, held in the University, Birmingham, on Wednesday, March 21st, 1923. The papers presented were all contributions from the Department of Glass Technology, The University, Sheffield.

The first one, entitled *A Rapid Method of Testing the Durability of Glassware*, by Mr. H. S. Blackmore, Miss Violet Dimbleby, and Prof. W. E. S. Turner, was read by Miss V. Dimbleby, who was thus the first lady to read a paper before the Society. The paper presented an account of a simple and rapid method for determining whether a sample of glass would withstand weathering sufficiently to enable it to fulfil certain purposes. The test consisted of the fact that when a very dilute solution of one part in 1,000 of the alkaloid narcotine hydrochloride is heated to boiling inside a glass vessel, the alkaloid is thrown out of solution, and can be seen as a fine precipitate if the glass is of poor quality. If this occurred at the end of ten minutes' heating, the glass was to we condemned; if within twenty minutes, the glass, although better, was still unsatisfactory.

Good glasses ought to show no sign of deposit when heated at the boiling point for an hour. It was pointed out that this test differed from all the others previously devised and used, in that it required no special chemical knowledge, could be carried out with very simple apparatus, and therefore was a test which could be applied in any factory. The test was shown to be thoroughly satisfactory by a large number of trials on all kinds of glassware.

The two other papers contributed were: *The Corrosion of Fireclay Refractory Material by Glass and Glass-making Materials*, by Mr. Donald Turner and Prof. W. E. S. Turner, and *The Effect of Saltcake in Corroding Fireclay Materials*, by Miss Edith M. Firth, Mr. F. W. Hodkin, and Prof. W. E. S. Turner. These two papers were taken together and presented by Prof. Turner, who detailed experimental evidence showing that in glass melting the corrosion of the pots or of the tank blocks was most severe during the early stages of the melting of the batch. The corrosion due to the glass itself was proved to be very much less.

Of the glass-making materials, sodium nitrate, potassium nitrate, and borax were particularly corrosive. Resistance to corrosion could be improved by firing the pots or blocks at 1,400° before the charge of batch was inserted. At temperatures round about 800 or 900° C., saltcake was not nearly so corrosive as soda ash. At the temperature of the melting furance, however, it appeared to be more corrosive, and it was demonstrated by a series of experiments that as the proportion of saltcake increased, so did the extensiveness of corrosion, even in batches in which coke, as a reducing agent or the saltcake, was present throughout.

During the forenoon a party of members visited the Longbridge Works of Messrs. Austin Motor Co., Ltd., Northfield.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Seventieth General Meeting.

At the House of the Royal Society of Arts, John Street, Adelphi, W.C.2.

On Tuesday, 10th April, 1923, the following paper will be read:

Potrero No. 4. A History of One of Mexico's Earliest and Largest Wells, by A. E. Chambers, M.Inst.P.T., Assoc.M.Inst.C.E.

The chair will be taken at 5.30 p.m. by the President, H. Barringer, M.Inst.C.E., M.I.Mech.E., M.I.N.A., M.Inst. Mar. Eng.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Wireless Section meeting, in the Lecture Theatre of the Institution, on Wednesday, 11th April, 1923, at 6 p.m. (Light refreshments at 5.30 p.m.)

The Application of a Revolving Magnetic Drum to Electric Relays, Siphon Recorders and Radio Transmitting Keys (Experimental Demonstration), by N. W. McLachlan, D.Sc. (Eng.), Member.

GENERAL NOTES.

BRITISH DYES "BOOM."

New Plant and an Order from Germany.

Extensive new plant is being installed at the Huddersfield works of the British Dyestuffs Corporation to meet the growing de-

mand created by the situation in the Ruhr and by a greater public confidence in British acids, intermediates and dyestuffs.

There has recently been a considerable increase in production of acids, intermediates and dyestuffs. This may be due in part to the occupation of the Ruhr, but is due mainly to the strengthening of confidence in the quality and uniformity of British dyes. Dye users, moreover, are always looking for a continuous supply of the right goods almost as much as for the right goods themselves. That is one reason why to-day many of them regard the Reparation material with much less favour than they did twelve months ago.

Inquiries are coming even from the Continent. A week or two ago one came from Brussels for mixed acid, and only the other morning there was another from Germany for nitric acid. This is something absolutely novel for the English chemical industry, and is symptomatic of the general outlook.

In the House of Commons recently, Mr. Short asked the President of the Board of Trade if he could state the total imports of alizarine and other anthracene dyes during the years 1913 and 1922 respectively.

Lieut.-Colonel Buckley, Secretary to the Overseas Trade Department, replied: The imports into the United Kingdom of alizarine and anthracene dyestuffs during the year 1913 amounted to 60,813 cwts., valued at £272,245. In the year 1922 the imports of alizarine dyes amounted to 11,387 cwts., valued at £60,607. Owing to a change in classification which became operative in January, 1920, separate particulars of the imports of anthracene dyes in 1922 are not available.

THE PHOTOGRAPHIC FAIR.

The Photographic Fair held at Holland Park Hall, W., from March 15 to 24, was characterised by a good display of exhibits.

Numerous photographic manufacturers showed the latest productions and devices in general apparatus, hand and folding reflex cameras, lenses, new films, ultra-rapid plates, &c. Good specimens of silver nitrate, gold chloride, potassium platini-chloride, etc., were exhibited by a well-known firm of manufacturers of photographic chemicals.

Besides these there were also exhibits of radiography, photomicrography, press photography, and colour reproduction. A section on "spirit photography" was arranged by the Editor of *Light*.

Some first-class prints by the professional photographers of other countries were also shown at one stand.

PYRIDINE SIMONSENS OIL AND WOOD NAPHTHA.

The Department of Overseas Trade have received a request from a Durban firm to be put in touch with firms in the United Kingdom who are in a position to supply pyridine, simonsens oil and wood naphtha. These materials are required for the denaturing of alcohol for the manufacture of methylated spirits.

The name and address of the applicant, together with further particulars, may be obtained by United Kingdom firms interested upon application to the Department of Overseas Trade, 35, Old Queen Street, Westminster, London, S.W.1 (Room 52). Reference number 10856/ED/CP should be quoted.

CZECHO-SLOVAK CHEMICAL INDUSTRY.

In the year 1922 only 50 per cent. of the larger Czecho-Slovak chemical factories were working, and the smaller ones were in more or less the same position. The reason for the small demand lay, as with other branches of industry, in the fact that prices were high owing to fluctuation in the Central European exchanges, German competition, etc., and consumption was consequently restricted, the result being a crisis on the chemical market. One circumstance is common to all these causes, namely, that they are beyond the control of the producer, so that the manufacturer himself can do nothing to remove them. Before the war, the chemical industry in Czecho-Slovakia was in a position to compete with any other, and had a large share in the exportation. Despite the unfavourable conditions of the times, the industry improved its arrangements and methods of business, so that its present constitution in this respect is to-day better than it was.

It is obliged to import most of its raw material from abroad. Thus more especially—pyrite from Spain, phosphate from America, Africa and Australia, salt from Germany and Austria, and fats from overseas. In this way the entire Czecho-Slovak chemical industry, both in its larger and smaller concerns, is dependent on the one hand on the importation of raw material from overseas, while on the other it must endeavour to export the finished products, as there is not sufficient demand for them in Czecho-Slovakia itself.

During the past year the Czecho-Slovak chemical industry aimed at selling off the existing supplies and at covering home consumption, which it is true, was gradually diminishing. The decrease in exports in 1921 is attested by the following statistics, but it should be borne in mind that the value of the Czecho-Slovak crown two years ago was not as high as it is now.

Of the chemical products which have chiefly to be considered, the following exports were effected:—

1920 for 1,480 million crowns.
1921 for 870 ,, ,,
1922 for 280 ,, ,,

The unemployment figures in the Czecho-Slovak chemical industry for January, 1922, expressed as 636, rose to 2,684 by September, 1922, of which 13 per cent. received doles direct from the State, and 42 per cent. were supported by various industrial concerns. The figures of last quarter are significant: in October there were 2,804 unemployed workmen in the industry, and subsequently in the month of November there is a gradual change for the better, with only 1,626 unemployed. The decrease in wages, which became a necessity last year, was carried through with less difficulty than was anticipated.

In consequence of the rise of prices in Germany, it would seem that Czecho-Slovakia will again be able to supply the demands from abroad, and her chemical industry is to-day actually in a position to compete with England, Belgium, and America in very many articles. As regards its organisation, it should be pointed out that the Czecho-Slovak chemical industries comprise 22 sections, of which each one forms a link between the undertakings of the individual branches of the industry. The entire Union is affiliated to the Central Federation of Czecho-Slovak Industries.

CZECHO-SLOVAKIA.

Demand for British Chemicals.

The Acting Commercial Secretary at Prague reports to the Department of Overseas Trade that the French occupation of the Ruhr district and the present industrial situation in Germany are undoubtedly having their effect on the local market, but the increased demand arising out of the abnormal conditions obtaining in Germany has, as yet, scarcely been noticeable, owing to the fact that the stocks on hand in this country have been sufficiently large to cover all requirements. In view of the general depression in the textile industry, even the demand for aniline dyes has been almost imperceptible, yet in normal times the Czecho-Slovak requirements in dyes were so large as to be an item of great importance even to the largest German works. The present stocks, however, will not last for any great length of time, and there is no doubt that sooner or later there will be a shortage of aniline dyes and higher prices will be seen, especially as German prices have now practically attained the level of those ruling in the international market. The effect of the occupation of the Ruhr on the Czecho-Slovak heavy chemical trade has been to arrest the falling tendency of prices.

Lower prices were expected for acetic acid, soda, borax, and chloride of lime, but in view of the temporary alienation of German competition no reduction whatever has taken place, and local prices are still two or three times higher than German prices, and often higher than those ruling in the Western States.

Following are the market prices of chemicals per kilo ruling in Prague on the 8th March:—

	Czech Crowns.
Acetone	21.00
Alum	4.35
Formic Acid (80 per cent.)	12.30
Benzoic Acid	38.00
Sulphate of Magnesia	1.40
Borax Crystals	6.50
Boric Acid	11.00
Chloride of Barium	3.20
Chloride of (chlorinated) lime	2.60
Chloride of Potassium	10.00
Chrome Alum	7.00

	Czech Crowns.
Dextrin	3.00
Green Vitriol or Copperas	0.60
Acetic acid 80 per cent.	18.00
Yellow cyanide of Potassium	30.00
Sulphate of Soda (powder)	0.90
Sulphate of Soda (crystals)	0.80
Permanganate of Potash	15.00
Nitrate of Potassium	7.00
Oxalate of Potassium	19.00
Blue Vitriol	8.00
Lime	8.00
Oxalic Acid	13.00
Paraffin	3.50
Sal Volatile 98/100	5.90
Liquid Ammonia 0.910	5.30
Nitric Acid 36° Be	3.00
Hydrochloric acid 20-22 p.c.	0.95
Shellac T.N. Orange	64.00
Sulphide of Sodium	3.80
Sulphide in pieces	1.80
Sulphuric Acid 66 per cent.	1.25
Tartaric Acid	25.00
Turpentine (French)	19.50
White Vitriol	2.80
Japan Wax	12.50
Carnauba Wax	16.00

In the House of Commons, Mr. Darbishire asked the President of the Board of Trade if he had received a communication from the British Chemical Trade Association, which was addressed to the Secretary of State for Foreign Affairs and passed on to him, containing proposals for the setting up of a licensing office in the Cologne area, which should be competent to deal with all consignments of British goods consigned to the United Kingdom or elsewhere overseas on British firms' account; and, if so, did he intend to endeavour to get it adopted by the Inter-Allied Rhineland High Commission?

Lieut.-Colonel Buckley said that he had received the communication referred to. There were three licensing offices (Bad Ems, Dusseldorf, and Essen) dealing with their respective areas. To set up a fourth at Cologne dealing with British trade would add to the confusion.

DEATH OF SIR JAMES DEWAR.

By the death of Sir James Dewar, F.R.S., the world in general and physical science in particular are the poorer.

His work on the liquefaction of air, nitrogen, oxygen, hydrogen, etc., represents one of the many great scientific achievements of the last century. This work led up to his invention of the vacuum flask which bears his name, and which was adapted to every-day domestic use in the form of the Thermos flask.

These discoveries not only led him into further investigations, but also prompted others to follow along lines which were only possible as a result of his work.

He was for many years, and until his death on March 27, connected with the Royal Institution, at whose meetings many of his discoveries were first announced. Here he followed and maintained the illustrious examples of great predecessors. Almost all the important scientific societies throughout the world have honoured him at some time or another.

NAPHTHENIC ACIDS FROM JAPANESE PETROLEUM.

By Y. Tanaka and S. Nagai.

On acidifying the waste lye from the refining of 25-26° Be petroleum distillate, a thick brown oil S.G. 0.9853 and acid value 68.8, sulphur content 0.89 per cent. was obtained. It emulsified with water, and gave an ether soluble copper salt indicative of naphthenic acids. Other compounds were, however, present. The naphthenic acids were separated and purified by hydrolysis of their methyl esters, the final product being a light yellow viscous liquid, S.G. 0.9918, refractive index 1.4824, acid value 254.3, mean mol. wt. 221, iodine value nil. By careful fractionation of the methyl esters, trideca, tetradeca, and penta decanaphthenic acids were isolated.—(From *J. Amer. Chem. Soc.*, 1923, XLV., 254-9.)

CORRESPONDENCE.

THE AUTHENTICITY OF THE LATIN WORKS OF GEBER.

To the Editor of THE CHEMICAL NEWS.

SIR,—I was much interested to read Mr. E. E. Whale's letter on the above topic, in your issue for March 9, and the excellent report of Mr. Holmyard's lecture on "Arabian Alchemy and Chemistry," which appeared in the previous issue. In that report you were kind enough to include my own remarks—to which I would draw Mr. Whale's attention—which perhaps sufficiently define my own position towards the question of Geber in the light of Mr. Holmyard's researches; but it may possibly be of use if I briefly expand these here. Like Berthelot, I know no Arabic, and in common with him and other writers on the history of chemistry, I had to rely, when writing *Alchemy: Ancient and Modern*, upon the translations of Geber's original works, which Berthelot had had prepared for the purposes of his own studies. Judging from these, no other conclusion seemed possible than that which Berthelot himself drew, namely, that the Latin words ascribed to Geber are spurious. For, whereas these Latin works are definite and practical treatises, the Arabic works are highly mystical in character. Moreover, these latter works make no mention of the famous sulphur-mercury theory of the metals which play so important a part in the Latin works. Mr. Holmyard, it is true, in controverting this argument, has not produced the Arabic originals of the Latin works; but he has discovered other Arabic MSS, the undoubted work of Geber—such as *The Book of Properties* in the British Museum —which are exactly like these in character; works which describe many practical preparations and make mention of the sulphur-mercury theory; and he suggests that the Arabic MSS. of Geber's which Berthelot had translated were not the chemical works of Geber, but religious works in which Geber—as a chemist—naturally made use of chemical symbolism.

I entirely agree with Mr. Whale that it is highly desirable that adequate translations should be made of the various Arabic MSS. in question, and it is to be hoped that Mr. Holmyard might be persuaded to undertake this important work. A translation of Geber's *Book of Properties*, for example, the MS. of which is in the British Museum, would be especially welcome. Until such translations have been made it may be as well to retain an open mind concerning the question of the authenticity of the Latin works; but certainly the evidence for reversing the decision arrived at by Berthelot, which Mr. Holmyard has already put forward, is, to my mind, very convincing.

As to the different spellings, "Geber" and "Dschabir," these are merely different transliterations of the same Arabic name, and do not refer to different individuals.—Yours, etc.,

H. STANLEY REDGROVE,
B.Sc., A.I.C., F.C.S.

191, *Camden Road, N.W.*1.
March 10. 1923.

[Owing to an error on the part of the printers, a portion of Mr. Redgrove's letter, which appeared in the issue of March 23, was inadvertently omitted. We publish above the letter in full, and tender apologies to Mr. Redgrove and our readers. —ED., *C.N.*]

NOTICES OF BOOKS.

Glue and Gelatin, by JEROME ALEXANDER. Pp. 236. New York: The Chemical Catalog Co. Inc., 19, East 24th St. 1923. Price 3 dollars.

The publication of this monograph under the direction of the American Chemical Society is well justified from the points of view of the principles of physical chemistry which it touches and the industrial importance of these substances as well as by their long use.

The subject is a difficult one. Much information is scattered through the scientific literature, but often under unexpected headings.

Another difficulty that the author must have encountered is the unequal quality of the work published, especially concerning their colloidal properties.

Most attention has here been devoted to well known theories which are expounded and discussed in the light of the properties

of glue and gelatin, and especially with reference to recent work on the latter.

In the chapter on their chemistry, the different estimations and calculations of the molecular weight of gelatin are given. It is interesting to note that the most recent computation puts this at about 10,300.

With regard to the testing of glue and gelatin, it is pointed out that no single test can satisfactorily grade a commercial sample. Many tests are necessarily of an empirical nature, and this must continue until a more exact knowledge of the chemical constitution of these bodies is forthcoming.

There are, however, certain specifications that can be determined and must be complied with in the case of gelatin intended for human consumption.

This raises the question how to distinguish gelatin from glue; there is, in fact, no sharp distinction. But gelatin for food must not contain, e.g., SO_2, As, Cu, Zn, or indeed, any injurious body.

The author is to be congratulated on this compilation, of interest both to technologists and physical chemists.

Anorganische Chemie, von DR. F. EPHRAIM. Zweite und dritte verbesserte Auflage. Pp. VIII. + 742. Dresden and Leipzig: Verlag von Theodor Steinkopff. 1923. Price unbound 8s. 6d., bound 10s. 2d.

There are now so many textbooks on Inorganic Chemistry that there seems little need for new publications covering the general theory and description of this subject.

Prof. Ephraim has, however, written one which has gone through two or three editions in the course of a few months, from quite a new standpoint, and which deserves the attention of chemists, and certainly has justified the publication of yet another *Inorganic Chemistry*.

This readable volume opens with an account of the present views concerning the structure of the atom, followed by a brief description of the elements and general chemical theory. The essential principles of physical chemistry are included.

In the next chapter, the compounds of the halogens are described, beginning with those with hydrogen. The hydracid salts, the oxides, oxy-acids, and compounds of the elements with one another complete this section.

Chapter three deals with the oxides of hydrogen, of the metals, and the acidic (higher and amphoteric) metal oxides. Following are chapters on the other elements in convenient groups. The mode of treatment is along the same lines, viz., first the hydrogen-compounds, then the oxides and salts, and finally the halogen and cyanogen compounds are described.

The inter-metallic compounds and metal hydrides, the rare earths, and the radio-active bodies all have separate chapters allotted to them.

By this arrangement the periodic system and other generalisations are made apparent.

Prof. Ephraim's stimulating and comprehensive volume could well be of service to those advanced science students studying German. Advanced workers and lecturers in inorganic chemistry will certainly notice many interesting points in connection with the mode of presentation of even the most recent developments in chemistry.

J.G.F.D.

The Chemical Technology and Analysis of Oils, Fats and Waxes, by DR. J. LEWKOWITSCH, M.A., F.I.C. Sixth edition, entirely. Revised by G. H. WARBURTON. Vol. III., pp. VIII. + 508. London: Macmillan & Co., Ltd., St. Martin's Street, W.C. 1923. 36s. net.

The publication of Vol. III. of Dr. Lewkowitsch's compendium on Oils, Fats and Waxes, now revised and brought up-to-date by Mr. Warburton, completes the sixth edition of this well-known standard work of reference; Vols. I. and II. having appeared last year.

The appearance of Vol. III. has been awaited somewhat impatiently by those who have had frequent occasion to consult this work, since it contains the subject index of the whole edition.

The matter of this volume, in addition to useful statistics and tabular information, contains much that is valuable to technical chemists, analysts and others requiring authoritative information on this important

and ever-expanding branch of industrial chemistry.

The British Association for the Advancement of Science have issued as a reprint the Report on *Absorption Spectra and Chemical Constitution of Organic Compounds.* The Committee responsible for the report consisted of Prof. I. M. Heilbron, Prof. E. C. C. Baly, and Prof. A. W. Stewart; and they have collected and reported upon the experimental work and theories put forward by numerous investigators in this field.

Readable School Chemistry, by J. A. COCHRANE, B.Sc. Pp. XI. + 84. London: G. Bell & Sons, Ltd., Portugal St., W.C.2. 1923. Price 2s.

Few elementary chemistry textbooks really appeal to young pupils just beginning the subject.

It is not proposed to enter into the causes of this here, beyond stating that Mr. Cochrane has written a volume which will appeal to them. The subject is developed historically, and the book is evidently intended to supplement the practical work; each chapter should naturally be studied after the experimental work has been completed.

The gradual development of chemistry as it is to-day, is traced in a manner calculated to sustain and stimulate the interest of beginners. In particular, the chapters on *Burning and Rusting* and *The Air and its Constituents*, are especially well written for schoolboys.

On p. 3 the author accurately indicates that the alchemical period dates from the Christian era to 1500 A.D., and not from earlier times. (Yet on p. 7 it is stated that "Egyptians practised alchemy five or six thousand years ago.")

This little volume can be warmly recommended for those scholars for whom it is intended. It would also be of service to those who do not intend to pursue the subject very deeply. The inclusion of several plates of historical and general interest, and its low price, are additional recommendations. J.G.F.D.

The Mathematical Theory of Relativity, by A. S. EDDINGTON, M.A., M.Sc., F.R.S. 10¼ins. x 7½ins. Pp. X. + 247. Cambridge: The University Press. Price 20s. net.

The Mathematical Theory of Relativity, by A. KOPFF. Translated by H. LEVY, M.S., D.Sc., F.R.S.E. 7¼ins. x 4¾ins. Pp. VIII. + 214. London: Methuen & Co., Ltd., 36, Essex Street, W.C. Price 8s. 6d. net.

Whereas, during recent years a very large number of popular expositions of the theory of relativity have appeared, English and American students desirous of really mastering the subject have been saddled with the double task (except as concerns the help afforded them by the translations of papers by Einstein and Minkowski, which were published in 1920 by the University of Calcutta) of studying a difficult subject in a foreign language. So great was the need that it might be said that almost any book dealing with the mathematics of the theory of relativity would be welcome. Especially welcome indeed, then, is this brilliant treatise by Professor Eddington, and not less so is the very readable translation of Professor Kopff's fine work. In many ways the two books show marked differences in the treatment of their subject matter; and each has an excellence characteristically its own. Professor Eddington's book is, perhaps, the more philosophical, as it is also the more novel in its mode of presentation; but, on the other hand, it is the more difficult to read and to master. The fact that it forms in a manner, a sequel to the author's previously published *Space, Time and Gravitation* accounts for its somewhat brief treatment of the restricted theory of relativity, which is dealt with very fully in Professor Kopff's work. Both books contain chapters devoted to the tensor calculus, which forms the necessary mathematical apparatus for dealing with the generalised theory, to a discussion of which, its various aspects and consequences, both books then pass. Professor Eddington's treatment is the fuller here—the problems of the curvature of time and space and of world-geometry generally being discussed at considerable length with special reference to the views of Einstein, de Sitter and Weyl. Two points made clear in the "Introduction" to Professor Eddington's book must not be passed over in this all too short

notice. One is that the physical qualities dealt with by science are essentially *manufactured articles.* "Physical quantities," he writes, "are not properties of certain external objects, but are relations between these objects and something else." The second point is that an intrinsic property of a measuring instrument must appear as *a uniformity in a series of measurements made by it, and that it is just such uniformities which constitute what are called* "laws of nature." The philosophical importance of such inevitable conclusions of the theory of relativity as these can hardly be underestimated.

Both these books can be unreservedly recommended to students. To read and to master one of them is to gain a very good working knowledge of the greatest scientific achievement of the present century. But certainly the student who is keen will not be content with this. He will read and master them both. H. S. REDGROVE.

BOOKS RECEIVED.

The Spectroscope and its uses in General Analytical Chemistry, by T. THORNE BAKER, A.M.I.E.E., F.R.P.S. Pp. X. + 208. Second Edition. 1923. Messrs. Baillière, Tindall & Cox, 8, Henrietta Street, Covent Garden, W.C.2. 7s. 6d. net.

The Phase Rule and its Applications, by ALEXANDER FINDLAY, M.A., PH.D., D.Sc. Pp. XVI. + 298. Fifth Edition. 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 10s. 6d. net.

Laboratory Manual of Physical Chemistry, by ALBERT W. DAVISON and HENRY S. VAN KLOOSTER. Pp. VIII. + 182. 1922. Messrs. Chapman & Hall, 11, Henrietta Street, Covent Garden, W.C.2. 10s. net.

New Patents.

THIS list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

6861—Booer, J. R.—Preparation of salts of boric acid. March 9.

6737—British Dyestuffs Corporation Co., Ltd.—Manufacture of formaldehyde or its polymers. March 8.

7009—*Consortium Für* Elektrochemische Industrie Ges.—Manufacture of anhydrides of fatty acids. March 10.

6598—Techno-Chemical Laboratories, Ltd.—Separating solids from liquids. March 7.

6596—Weber, W.—Process for treating ammonium chloride lyes in iron vessels. March 7.

7747—Aktieselkabet Hydropeat.—Manufacture of colloidal solutions of ferric oxide. March 17.

7770—British Cellulose & Chemical Manufacturing Co., Ltd.—Treatment of cellulose acetate, etc. March 17.

Abstract Published this Week.

191854—Dyes.—Soc. of Chemical Industry in Basle; Basle, Switzerland.

Triarylmethane dyes are obtained by condensing phenyl-chloroform or a substitution derivative or homologue thereof, or 1-chloro-2-naphthyl-chloroform, with naphthol or a substitution product thereof having a free 4-position, in presence of a substance neutralising acid; addition of a catalyst, for instance copper or alcohol, is advantageous. The dyestuffs derived from 1-naphthol-2-carboxylic acid dye wool grey tints changed by afterchroming to green or blue tints fast to fulling and potting; they may also be dyed or printed on chrome-mordanted fabrics, or used in single-bath processes. According to examples dyestuffs are obtained from β-naphthol and phenyl-chloroform in the presence of caustic soda, and from 1-naphthol-2-carboxylic acid and phenyl-chloroform in presence of copper powder and caustic soda, lime, or magnesia. The several chlorphenylchloroforms, and the sulpho derivatives of 1-naphthol-2-carboxylic acid, such as 1-naphthol-7-sulpho-2-carboxylic acid are also mentioned as suitable components.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3287.

THE INTERACTION OF AMMONIUM HYDRATE AND MERCUROUS BROMIDE.

By J. G. F. Druce, M.Sc. (Lond.), R.Nat.Dr. (Prague).

Some time ago, on account of its theoretical and photographic interest, the action of ammonium hydrate upon mercurous chloride was quantitatively investigated (see *The Chemical News*, 1921, CXXIII., 153).

It was concluded that the results were expressed by the equation:—

$$2NH_4OH + Hg_2Cl_2 = NH_2Hg_2Cl + NH_4Cl + 2H_2O.$$

The action of ammonium hydrate upon mercurous bromide has now been examined in a similar manner.

For this purpose mercurous bromide was prepared by precipitating an acidified solution of mercurous nitrate with slight excess of potassium bromide. The almost white precipitate was filtered off with the aid of a filter pump, and washed repeatedly with warm water to remove any potassium nitrate or acid adhering to it. It was finally drained and dried.

0.9380 gram was placed in a stoppered flask with about 25 cc. of water. Twenty cc. of a normal solution of ammonium hydrate were added. The stopper was replaced, and the mixture was shaken for a few minutes and allowed to stand for two days. The black residue was then removed as quickly as possible by filtration, and was washed with distilled water. Filtrate and washings were made up to 200 cc.

The residual ammonia was estimated by titrating lots of 20 cc. of this diluted filtrate with decinormal hydrochloric acid. The average volume of acid required in these experiments was 16.7 cc., which corresponds with 0.5836 gram ammonium hydrate in the whole filtrate. Therefore 0.1164 gram had reacted with the mercurous bromide.

The quantity of ammonium bromide formed was determined by taking three lots of 20 cc. of the diluted filtrate obtained above and boiling for five minutes to expel the free ammonia. This solution was then titrated with fiftieth normal silver nitrate solution. The average volume required in the three experiments was 8.35 cc., which indicates that the total filtrate contained 0.1632 gram ammonium bromide.

Thus, 0.1164 gram of ammonium hydrate reacted with 0.9380 gram of mercurous bromide, forming 0.1632 gram of ammonium bromide.

These results indicate that two molecules of ammonium hydrate act on one of mercurous bromide and one molecule ammonium bromide is produced.

The other product of this interaction was the "black precipitate," which could be NH_2Hg_2Br, or a mixture of NH_2HgBr and finely divided mercury.

At the end of the article previously cited, the same question was considered in connection with the corresponding chloro-compound, and the conclusion was drawn that the substance was a compound, since it did not appear to amalgamate with copper.

The black precipitate obtained in these experiments amalgamated readily when rubbed on a bright piece of pure copper when freshly prepared.

When washed quite free from ammonia it did not amalgamate so readily, and when dry, amalgamation was still more difficult but could, nevertheless, be effected.

This strongly suggests that the black precipitate is a mixture.

Additional support for this has been obtained by boiling the substance with a strong solution of ammonium bromide. By this means the free mercury was obtained in the form of a fair-sized globule, whilst the white mercuric bromo-amide, NH_2HgBr, dissolved. This latter substance crystallised out when the hot saturated solution cooled.

Thus it has been established that when ammonia acts upon mercurous bromide, the reaction may be expressed by the equation:—

$$Hg_2Br_2 + 2NH_4OH = NH_2HgBr + Hg + NH_4Br + 2H_2O.$$

It was thought of interest to ascertain whether by using excess of mercurous bromide with ammonium hydrate, any free acid could be liberated as the following equation suggested:—

$$NH_4OH + Hg_2Br_2 = NH_2HgBr + HBr + H_2O + Hg.$$

With this in view, 3.5 grams mercurous bromide were ground up in a mortar with

20 cc. of water and 5 cc. of normal ammonium hydrate. When drops were tested with phenol-phthalein, methyl-orange, and litmus, all three indicators showed that the mixture was neutral, therefore no free hydrobromic acid could have been formed.

Since it was clearly proved that the insoluble product of the interaction of ammonium hydrate and mercurous bromide was a mixture of mercury and mercury bromo-amide, it was deemed important to further investigate the corresponding product from mercurous chloride.

On careful examination it was found that the wet "black precipitate" just as it was prepared, readily amalgamated with pure copper, but less readily when free from ammonia and least easily when dry.

Finally, when this "black precipitate" was boiled with a strong solution of ammonium chloride the mercury ran together to form one globule, whilst on cooling the supernatant liquid it deposited the infusible white precipitate.

The reaction between ammonium hydrate and mercurous chloride is thus in accordance with the equation:—

$$Hg_2\,Cl_2 + 2NH_4OH = NH_2\,Hg\,Cl + Hg + NH_4\,Cl + 2H_2O.$$

The International Institute of Agriculture, Rome, has issued a communication comparing the world's crops of 1922 with pre-war figures.

The statistics collected indicate that the production of maize in Europe is now only 62 per cent. of that grown annually before the war. The world's vintage is 21 per cent. above the average 1909-1913 figure.

Other important data are given.

CALCIUM ARSENATE FOR THE U.S.A.

The Commercial Counsellor at Washington (Mr. J. J. Broderick) reports that three firms of wholesale druggists in New Orleans are desirous of receiving samples and quotations for the supply of calcium arsenate. One of the firms also desires to import arsenic as well as Paris green.

Further particulars, together with the names and addresses of the applicants, may be obtained by United Kingdom firms on application to the Department of Overseas Trade (Room 52).

VALENCY.

By William R. Fielding, M.A., M.Sc., (Vict.).

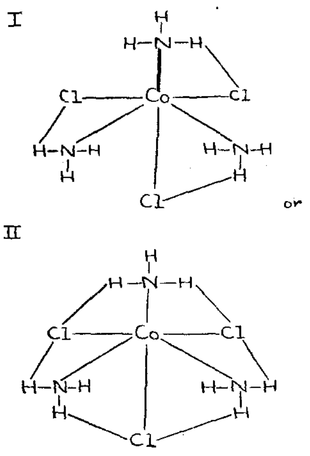
Senior Science Master, King Edward VII. School, Lytham.

(Continued from Page 214.)

The Cobaltammines.

$CoCl_3\,(NH_3)_3$, which is non-ionisable, may be written thus:—

$Co\,(NH_2.HCl)_3$:—



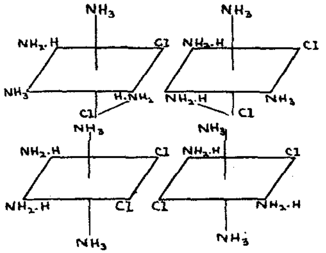
(Fig 3b)

$Co\,(NH_2.HCl)_3$.

As the chlorine is linked up with hydrogen as well as cobalt, neither the chlorine nor the nitrogen are exerting their maximum "pull" on the cobalt, and the latter is open to the attack of other negative groups. Each additional ammonia molecule breaks up a ring (two rings in the second formula), and the heat-change affects the valency of everything in the complex molecule. The action of successive molecules of ammonia may be represented thus:—

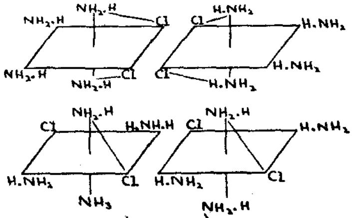
$[CoCl_3(NH_3)_3] = Co(NH_2.HCl)_3$
$[Co(NH_3)_2(NH_2.HCl)_2]Cl$
$[Co(NH_3)_4(NH_2.HCl)]Cl_2$
$[Co(NH_3)_6]Cl_3$

From formula I. in Fig. 36, four isomers of $[Co(NH_3)_4]Cl_2$ could be secured thus:—



(Fig 37)

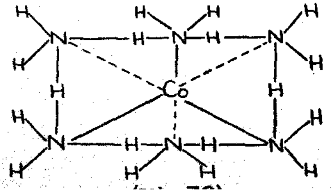
and from formula II. in the same Fig. four isomers (two being mirror-images), thus:—



(Fig 38)

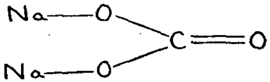
If the NH_3 acts as a single unit and not as H.NH.H and NH_2.H, the last two are alike, as are also the two former.

When all the chlorine has been replaced by ammonia the final form will present the following appearance (a plane figure is used to show valencies only):—



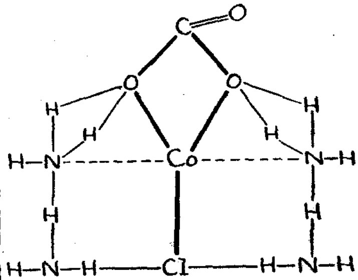
Co is hexad; nitrogen is pentad in three cases and tetrad in three other cases; it can become pentad all round by joining direct to the central atom. Cobalt will then have a valency of nine, six joining electro-negative nitrogen atoms, and three joining electro-negative chlorine atoms. This high valency is, in a way, a kind of reflected glory, and owing to borrowing electrons from the six electro-negative nitrogen atoms it is able to ionise the three chlorine atoms.

A similar procedure is adopted in evolving the formula of cobalt pentammine containing the CO_3 group. In carbonates (Fig. 40) the metal is not joined directly to the carbon.



(Fig 40)

Four molecules of ammonia combine with the $Co(CO_3)X$, thus:—

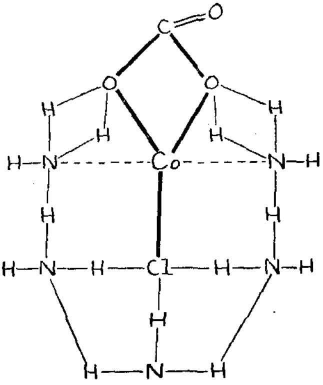


(Fig 41)

Here Co is triad, nitrogen triad and tetrad, hydrogen dyad and monad, oxygen dyad and tetrad, and chlorine triad. The two tetrad nitrogen atoms are each joined to three hydrogen atoms which are functioning as dyads; these three atoms will not utilise as much of the valency-strength of the nitrogen atom to which they are at-

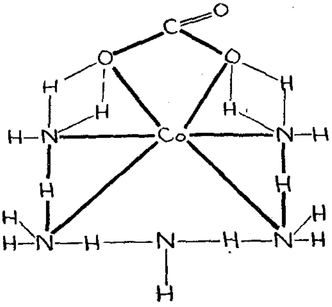
tached as the three atoms of hydrogen in NH_3 do; these N atoms are thereby able to effect linkages with the cobalt which is likewise not extended to its full valency-capacity because it is joined to three atoms which are functioning as tetrads and triads, their usual valencies being dyad and monad respectively. These two nitrogen atoms may, and probably do, connect up with the cobalt, and the valencies are shown in dotted lines.

The fifth ammonia can now be added, and it tackles the chlorine end of the molecule. The following formula is suggested:



(Fig 42)

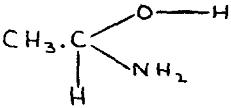
The chlorine atom is now ionised, when the following redistribution of valencies occurs:—



(Fig 43)

An alternative method would be to group the NH_3 molecules without attempting to explain how two pentavalent nitrogen atoms link each other. Nitrogen would be pentavalent throughout, and bonds numbers 1 and 2 would be cancelled. (These bonds, which are not shown in the figure, join the cobalt atom and the two lower N atoms.)

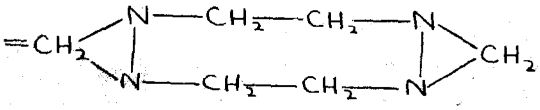
The group $=C=O$ behaves differently towards ammonia according to the group to which it is joined. With acetaldehyde, etc., it forms an addition compound, as in Fig.44.



(Fig 44)

and with formaldehyde, hexamethylenetetramine (Fig. 45):—

$$6CH_2O + 4NH_3 = (CH_2)_6N_4 + 6H_2O.$$



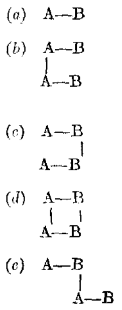
Conclusions.

(1) Valency is a variable property of elements, the variability depending on the element, the temperature, the pressure, and the element or elements with which it is combined.

(2) In many simple chemical actions the Law of Conservation of Principal Valencies holds, the temperature remaining constant; but

(3) In an exothermic action the degree of polymerisation is greater than the average calculated from the constituents. That is, as the amount of energy in the system is reduced the degree of polymerisation is increased. This is in agreement with the known facts that p is reduced as temperature rises, except in the case of endothermic compounds.

(4) As p is increased the usual valency of elements must be increased also. This may be explained by the following linkages:



(5) Where two electro-positive or two electro-negative atoms are linked together, one may be regarded as electro-positive to the other, this being effected by a change in the electronic orbits or by the nuclei attracting each others free electrons.

(6) By carefully selecting the most suitable conditions of temperature, pressure, elements, etc., and making use of the changes in valency following every physical and chemical change and also by judicious "loading" of the central atom, valencies can be increased beyond those generally associated with the element. As Co, Pt, Cr, etc., can be joined to six atoms or groups as well as to several atoms which are ionised in solution, their valencies in the solid state (where some degree of polymerisation will almost certainly take place) will be considerably higher than the number of the group to which these elements belong in the Periodic Table. Their valencies may be reduced by supposing that the co-ordinated elements exert a single resultant valency towards the central atom.

(7) When compounds decompose on heating, melting, or boiling, the valency of the two elements for each other must be zero at that particular temperature and pressure.

(8) Several instances have been given where it is suggested that an atom "compensates" or "accommodates" another atom in the matter of electrons. Thus hydrogen often functions as a dyad, where its electron may be supposed to be shared between two electro-negative atoms.

January 17th, 1923.

THE INFLUENCE OF HUMIC ACIDS ON THE ASSIMILATION OF PHOSPHORIC ACID.

By K. Mack.

Phosphoric acid occurs in the soil in the form of primary, secondary and tertiary phosphates of the alkalies, alkaline-earth metals, aluminium, iron and manganese. It is perhaps also present as the tetraphosphate of certain metals. The water of the soil which contains phosphate ions becomes separated from the insoluble phosphates through the action of calcium, magnesium, aluminium and iron-hydrates, magnesium and iron-carbonates and certain silicates. Through the activity of soil bacteria, which, during respiration, produce carbon dioxide and, in disintegrating organic substances, produce acetic, lactic, butyric, and valeric acids, the insoluble phosphates become partly soluble again. In soils rich in organic substances, a large quantity of humic acids is formed which renders the phosphates soluble. Phosphoric acid is found in the soil not only as a mineral, but also in the form of organic compounds, such as phosphatids (lecithin), phytine and nucleoproteids, as is shown by the work of Stoklasa and others. These organic combinations are due to the remains of plants incorporated in the soil (stubble, roots, etc.). Stoklasa observed that the phosphoric acid combinations found in the soil are much more energetically assimilated, under the action of bacteria, than pure insoluble phosphates. He also concluded that the soil contains other forms of phosphates than those recognised

hitherto, notably easily-assimilated humophosphates.

The writer has made a series of experiments with the object of determining the effect of humic acids on the various phosphates. The acid used was extracted from peat, which was treated with sulphuric acid to separate the alkaline humates: 10 grs. of pulverised "humic" acid were added to a quantity of phosphate corresponding to 0.01 gram-molecule of phosphoric acid and the whole was left for 48 hours in a litre of water, and was frequently stirred. The results proved that humic acids render soluble the following quantities of phosphate, expressed in per cent. of phospboric anhydride: 29.45 per cent. of di-calcium phosphate, 28.46 per cent. of tri-calcium phosphate, 12.54 per cent. of tertiary aluminium phosphate, and 7.46 per cent. of tertiary iron phosphate. Humic acids therefore dissolve insoluble phosphates. They act on di-calcium phosphate in the same way as on tri-calcium phosphate.

Humic acids act differently when alkalis are present. Thus, humate of ammonia renders soluble less tri-calcium phosphate than in the former case (23.08 per cent. P_2O_5 as against 28.46 per cent.), but, on the other hand, much more tertiary aluminium phosphate (23.77 per cent., as against 12.54 per cent.), and tertiary iron phosphate (20.37 per cent., as against 7.46 per cent.).

With metallic oxides, humic acids and humates are capable of forming complex combinations, containing the metal in the anion. Thus, ammonium humate may combine with aluminium and iron phosphates to form compounds containing, besides iron and aluminium, phosphoric acid, otherwise known as salts of a "humophosphoferric" acid and a "humophosphoaluminic" acid. Pure humophosphoferric acid has been isolated; it is a bituminous, blackish-brown substance, soluble in alcohol up to 2.65 per cent.

In a soil rich in bone and lime phosphates only 3.5 per cent. of phosphoric anhydride were found to be present, which agrees with the fact that marshy soils rich in lime are not very fertile. From a garden rich in mineral and organic fertiliser, 25.27 per cent. of anhydride were obtained.

The excess of bases over phosphoric acid shows that the latter is present especially as a basic phosphate. In soils with an alkaline reaction, aluminium and iron phosphates are combined with the humic basis, which explains their greater fertility.

Humophosphoferric and humophosphoaluminium acids therefore serve to supply plants with phosphoric acid, and perhaps with iron and aluminium in a form which can be easily assimilated. This was fully confirmed in a series of experiments in which beets were cultivated in various nutritive solutions, of which some were exclusively mineral while others contained humate of ammonia. After 18 days, there was still considerable quantity of phosphoric acid in the first solutions, while the second contained no further traces. Other experiments are being made. Already preparations of peat and ashes used as fertilisers, and the addition of iron hydrate to the ordinary fertilisers have given good results.

The writer concludes by saying that greater importance should be attached to raw phosphates containing oxide of iron, such as those of Bavaria and the Hartz mountains; he isn ot in favour of the use of superphosphates, which eventually render the soil too acid. The use of manure, on the other hand, should be widely developed. In regions where, from climatic or economic reasons, it is impossible to rear livestock, peat may be used with advantage, for it not only renders phosphoric acid assimilable, but also furnishes nitrogen, and is a good medium for bacteria.—(From the *Chem. Zeit*, XLVI., pp. 73-5.)

GENERAL NOTES.

GERMANY'S POTASH INDUSTRY.

An extract forwarded to the Department of Overseas Trade by the Commercial Secretary at Cologne states that a number of potash works in Central Germany have been compelled to restrict work owing to unfavourable sale conditions. During 1922 boom conditions prevailed on the potash market, but in January of this year sales had already weakened, and the sale figures did not equal those of January, 1922. Fears were expressed that inland business would suffer a considerable decrease this year. These fears have now been realised. The German agricultural industry has greatly restricted its orders during the past few weeks, and in part has stopped them altogether, the cause of which is to be found in the disparity between the costs of

production and the sale prices for agricultural products.

It was to be foreseen that the improvement of the mark and the accompanying price reduction would also have its dark side. In the interests of guaranteeing food supplies, special attention will in the near future have to be given to agricultural conditions. The price reduction in corn, potatoes, etc., is in no proportion to the reduction in the costs of production, and landowners are, therefore, no longer in a position to devote the same expenditure as heretofore to the supply of artificial manure.

It goes without saying that the potash industry has been hard hit by the decline of the inland demand, and a great number of potash works have had to restrict work. Export sales do not recompense for the loss of the inland business. The potash business with America has not justified expectations, and it is, moreover, reported that the Alsatian potash works are doing their best to obtain the American market, and are under-bidding. The American farmer is, therefore, assuming a certain aloofness, expecting no doubt that the German potash works will also soon be compelled to reduce their prices.

The price question is to-day, in fact, the essential point in the sale problem. On the one hand, should the present prices be retained, there is no hope of increasing sales, and the closing down of works will be unavoidable. A reduction, on the other hand, endangers, in view of the increased costs of production and especially in view of the increased wages, the financial basis of the potash industry, which has only just been re-established. As, however, in the present conditions, the economic policy of the various industrial groups is dictated in the first place by general economic reasons, the potash industry will no doubt decide upon a reduction of its prices, in order to revive inland sales.

THE ECONOMIC POSITION IN CZECHO-SLOVAKIA.

The British Vice-Consul at Prague (Mr. J. W. Taylor) has forwarded to the Department of Overseas Trade a survey of the industrial situation in Czecho-Slovakia, by Dr. Hodac, the Secretary-General of the Federation of Czecho-Slovak Industrials. Dr. Hodac's statements are always carefully considered.

An improvement has taken place in the sale of coal and coke, in the output of pig-iron, steel and rolled-iron manufactures. At the end of December, three blast furnaces were in operation; to-day seven are being worked; but even now no less than 15 are idle. This improvement is connected with special temporary causes.

On the other hand, unemployment in the engineering trade has shown no improvement.

In the chemical industry, a bigger demand for sulphuric acid has been noted in connection with the use of coke. Those branches of industry which were doing comparatively well last autumn, and which felt the crisis only later, viz., the varnish factories and the technical chemical industry, are now feeling the slump in the same way as the colour factories do. Employment in the wood pulp industry is good; in the paper industry it has improved somewhat in regard to a few kinds only. There has been a considerable demand for leather of all kinds.

The position in the glass industry remains unfavourable. In the window glass branch there are about 900 workmen employed out of 5,000. In the bottle factories 700 workmen are employed, instead of 3,500. In the mirror and cast glass factories only 1,440 workmen are employed out of 2,400. At the end of December the number of workmen employed in the manufacture of hollow glass was 7,864, and in February 8,375, but the normal number is 20,000.

Lieut.-Colonel Buckley informed Mr. Graham White that the following statement showed, for each of the years specified, the quantity and the declared value of the imports into the United Kingdom, registered as consigned from the United States of America, of intermediate coal tar products used in the manufacture of dyes, and of finished dyestuffs obtained from coal tar, respectively:

Description.	1920. Quantity. Cwts.	Value. £.	1921. Quantity. Cwts.	Value. £.	1922. Quantity. Cwts.	Value. £.
Intermediate coal tar products used in the manufacture of dyes (including aniline oil and salt and phenyl glycine)	44,527	736,221	1,324	27,891	1	8
Finished dyestuffs obtained from coal tar	15,636	532,897	1,218	35,576	150	1,444

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on April 13 was delivered by W. H. ECCLES, D.Sc., F.R.S., M.I.E.E., M.R.I. His subject was *Studies from a Wireless Laboratory*.

On Monday, April 9, the General Meeting was held.

ROYAL SOCIETY OF ARTS.

The Cantor Lecture (1) ,entitled *Nitrates from Air*, was delivered on April 9 by E. KILBURN SCOTT, M.I.E.E., A.M.INST.C.E.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

ORDINARY MEETING,

Held at the Chemical Society's Rooms, Burlington House, on April 4, Mr. P. A. Ellis Richards, President, in the chair.

Certificates were read for the first time in favour of Mr. Robert C. Grimwood, A.C.G., F.C., D.I.C., A.I.C., and for the second time in favour of Messrs. John Myers, F.I.C., and John Loudon Buchanan, F.I.C.

The following were elected members of the Society: Messrs. Joseph John Valentine Backes, A.R.C.Sc., A.I.C., D.I.C.; Francis Fenelm Donovan, B.Sc. (Lond.); Alfred Edward Johnson, B.Sc. (Lond.), F.I.C., A.R.C.S.I.; Ernest Victor Jones, F.I.C.; S. Gordon Liversedge, F.I.C.; Samuel Gordon Stevenson, A.I.C.; Richard William Sutton, B.Sc.Tech. (Manc.), A.I.C.; Laurence Barnett Timmis, M.Sc. (Tech.) Manc., A.I.C.

The following papers were read:—

Physiological Standards, by DR. STANLEY WHITE.

Abstract.

Since many important drugs used in medicine do not lend themselves to chemical standardisation it is necessary to adopt physiological standards. A number of individual drugs, including digitalis, ergot and cannabis indica were dealt with, and a method described of arriving at the minimum lethal dose on frogs, and so establishing a heart tonic unit. The standardisation of Pituitrin was discussed, and physiological methods for determining the presence of the three vitamins. The paper was illustrated by numerous slides.

The Estimation of Boric Acid in "Liquid Eggs" and other Foodstuffs, by G. W. MONIER-WILLIAMS, M.A., PH.D., F.I.C.

Abstract.

The author draws attention to the irregular results sometimes obtained with Thompson's method owing to loss of boric acid by precipitation as calcium borate during the removal of phosphates. A method is described in which phosphoric acid is removed by precipitation is magnesium ammonium phosphate, the subsequent titration of the boric acid being carried out by Thompson's method.

An Investigation into the Chemistry of the Reinsch Test for Arsenic and Antimony, and its extension to Bismuth, by B. S. EVANS, M.B.E., M.C., B.Sc., F.I.C.

Abstract.

A summary of the literature relating to the reaction is given. A method is described for determining the velocity of the

reaction, and a number of curves are given showing the influence on the reaction velocity of varying chloride, acid strength, or arsenic (antimony, etc.), also the effect of adding cupric or cuprous salts. The products of the reaction are:—

For Arsenic—the compound Cu_5As_2.

For Bismuth—the element Bismuth.

For Antimony—the compound Cu_2Sb, followed by deposition of the element antimony.

In all cases cuprous chloride goes into solution.

An attempt was made to elucidate the mechanism of the reaction, and a number of experiments are described leading to the conclusion that it is due to reduction of the arsenic (or antimony, etc.) by a film of hydrogen on the surface of the copper. Under certain given conditions the test used qualitatively can be made sensitive to less than 0.01 mgrm. per 100 cc.

It is suggested that a determination of the reaction velocity carried out in any doubtful liquid will readily show whether any substance is present which would interfere with the test.

THE OPTICAL SOCIETY.

A meeting was held at the Imperial College, Imperial Institute Road, on Thursday, April 12th. The following papers were read and discussed:—

The Hilger Microscope Interferometer, by F. Twyman, F.Inst.P.

On the Form of the Wave Surface of Refraction, by A. Whitwell, M.A.

Mr. J. H. Barton also exhibited a new research microscope of original design.

By the courtesy of Messrs. The Hadley Company, makers of gold-filled spectacle frames and mounts, a visit has been arranged to their works at Portsmouth Road, Surbiton, Surrey, on the afternoon of Thursday, April 26, 1923. Fellows and Members desiring to avail themselves of the privilege of visiting these works should advise the Hon. Secretary (Business) at the Imperial College, not later than Saturday, April 21.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

An ordinary meeting was held on Thursday, April 12. A paper entitled *The X-Ray Examination of Materials*, was read by A. G. Warren, Member.

At the conclusion of the lecture, Mr. E. E. Brooks exhibited some lantern slides illustrating lines of electric force.

THE INSTITUTE OF METALS.

A General Meeting of the Institute of Metals will be held at the Institution of Mechanical Engineers Storey's Gate, Westminster S.W.1, on Wednesday May 2, 1923 at 8 p.m. when the thirteenth annual May Lecture will be delivered by Dr. W. Rosenhain, F.R.S., *Vice-President*, on *The Inner Structure of Alloys*.

IRON AND STEEL INSTITUTE.

The Annual Meeting of the Institute will be held, by kind permission of the Council of the Institution of Civil Engineers, at Great George Street, Westminster, on Thursday and Friday, the 10th and 11th of May, 1923.

Programme of Proceedings.

Thursday, May 10th.

10 a.m.—General meeting of members. The Council will present their Report for the year 1922. The hon. treasurer will present the statement of accounts for 1922. Scrutineers will be appointed for the examination of voting papers. Election of Council. Presentation of the Bessemer Medal to Dr. W. H. Maw.

A resolution, formal notice of which was given at the autumn meeting, on September 5th, 1922, of the alteration of By-Law 10, relating to the election of the President, will be submitted. The terms of the present by-law are as follows:

> "The President shall be elected for two years, and shall not be eligible for re-election until after an interval."

The terms of the resolution are:

> "That the By-Law shall be altered as follows: 'The President shall be elected for one year,' and to omit the words: 'and shall not be eligible for re-election until after an interval.'"

A selection of the following papers will be read and discussed in the afternoon session, and also during Friday, May 11:—

C. A. Ablett, *Economic Principles governing the use of Electrical Power in Iron*

and Steel Works.

J. O. Arnold, F.R.S., *On the co-relation of the Chemical Constitutions of "True Steels" to their Micrographic Structures.*

C. R. Austin, *Some Mechanical Properties of a series of Chromium Steels.*

L. E. Benson and F. C. Thompson, *Some Experiments on Grain-growth in Iron and Steel.*

H. C. H. Carpenter, F.R.S., *The Production of Single Metallic Crystals and some of their properties.*

F. Clements, *British Steel Works Gas Producer Practice.*

T. P. Colclough, *The Constitution of Basic Slags—its relation to Furnace Reactions.*

C. H. Desch and A. T. Roberts, *Some Properties of Steels containing Globular Cementite.*

C. A. Edwards and C. R. Austin, *A Contribution to the Study of Hardness.*

J. E. Fletcher, *Some Characteristics of Moulding Sands and their Graphical Representation.*

D. Hanson and J. R. Freeman, *The Constitution of the Alloys of Iron and Steel.*

E. J. L. Holman, *Note on a Value for the Surface Tension of Iron Sulphide.*

K. Honda and T. Murakami, *The Structural Constitution of Iron-Carbon-Silicon Alloys.*

J. J. A. Jones, *The Ac1 Range in Alloy Steels.*

J. W. Landon, *Change of Density of Iron due to Overstrain.*

F. C. Langenberg, *An Investigation of the behaviour of certain Steels under Impact at different Temperatures.*

T. Matsushita, *Some Investigations on the Quenching of Carbon Steels.*

L. Northcott, *A Note on Temper Carbon.*

H. O'Neill, *Variation of Brinell Hardness Number with Testing Load.*

T. F. Russell, *The Potential Energy of Cold Worked Steel.*

J. Stead, *The Cold Working of Steel with reference to the Tensile Test.*

E. R. Sutcliffe and E. C. Evans, *The Reactivity of Coke as a factor in the Fuel Economy of the Blast Furnace.*

F. C. Thompson and A. Goffey, *The Changes in Iron and Steel below 400° C.*

J. H. Whitley and A. Braithwaite, *Some Observations on the effect of small quantities of Tin in Steel.*

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The following paper was read at the Royal Society of Arts on Tuesday, April 10, 1923:—

Potrero No. 4.: *A History of One of Mexico's Earliest and Largest Wells*, by A. E. Chambers, Assoc.M.I.C.E.

Potrero No. 4 is one of the largest producers in Mexico, having given over one hundred million barrels of oil before salt water appeared. Its technical history is little known, and it is in the hope that a detailed description of the life of this well will interest the members that this paper is presented to the Institution.

The career of the well was an eventful one; it was brought in uncontrolled in December, 1910, brought under control in March, 1911, developed large seepage areas in its vicinity early in 1914, caught fire in August of that year, was extinguished early in April, 1915, produced under partial control for nearly four years, until December, 1918, when its production turned to an emulsion, which continued until April, 1919, when the well was finally closed in.

It is situated in the State of Vera Cruz, some 50 kilometres north-west of Tuxpam.

The specific gravity of the crude oil was 0.931° at 60° F., its temperature at the well was 147° F., and the pressure when the well was closed in was found to be 825 lbs. per square inch.

At first, all endeavours were devoted to saving the oil, but it was soon apparent that the quantity being produced was too great to attempt storing it; a careful calculation made in December, 1910, showed that the well was then flowing at the rate of 100,000 barrels in 24 hours. The Buena Vista River, previously mentioned, is the natural drainage for the area where this well is situated, and it was down this stream that immense quantities of oil flowed and were burnt many kilometres away.

It was evident that the only thing to do to save this well and its production, was to bring it under control. Owing to the great pressure and volume of oil, no ordinary method could be used, and several schemes were suggested; finally, however, an appliance, now fairly well known under the name of a "Bell Nipple," was devised and successfully installed in January, 1911.

On August 14, 1914, a severe lightning storm visited the neighbourhood, and set fire to the gas escaping from the well; this gas fire melted some lead gaskets in the joints of the flow line near the well head. The oil from these joints caught fire, also the oil leaking from the bell nipple; the fire rapidly spread to the seepages, and very quickly this large area was completely involved. It was unfortunate that the occurrence coincided with a period of great revolutionary activity and when the American Government had actually advised its nationals to leave Mexico. Practically all the skilled American oilfield workers had therefore left Potrero, leaving operations in charge of a small number of British and other nationalities. These few men were inadequate to deal with the fire in its early stages, and before others could get on the scene, the fire had assumed enormous proportions.

By March 24, 1915, the fire was totally extinguished, and all that remained of the well to be seen was a large earthen mound with numerous gas pipes sticking out from it. After a few weeks the action of the gas on the clays forming the mound had converted them into a loose powdery material, and the gases, instead of coming only from the gas pipes, were exuding from all over the mound. It was thought that this condition of affairs should not be allowed to remain, as, if through lightning or any other cause, the gases became ignited, it was difficult to feel certain that some serious damage might not eventually occur. The whole mound was, therefore, covered with a reinforced concrete cover; the cover being designed by the use of suitable steel frames to be entirely self-supporting, and, in fact, to form a species of inverted cup placed over the earthen mound but not in contact with it. Numerous pipes were inserted in this concrete cap, and the gas coming therefrom was led away and burnt at flares at a safe distance. The well in this condition produced without misadventure until December, 1918.

SOCIETY OF CHEMICAL INDUSTRY.

Birmingham and Midland Section.

The following papers were read at the meeting on March 27:—

Oil Hydrogenation, by E. J. Lush, M.A.

The physical conditions of the addition of hydrogen to oils, by means of nickel, acting as a catalyst, lent themselves naturally to continuous working. The catalyst being a solid, the oil a liquid, and the substance producing the desired change, viz., hydrogen, a gas, it should be possible to distribute nickel throughout a closed vessel, keep the vessel full of hydrogen, and allow oil to run in at one end and out at the other—the speed of flow regulating the degree of hydrogenation.

Reaction between Ammonia and Sodium Hypobromite, by D. R. Nanji, M.Sc., and W. F. Shaw, M.Sc.

When ammonia is added to excess of alkaline sodium hypobromite, it is decomposed. That this reaction is not the only one that occurs has not been recognised by certain investigators since it has been suggested as the basis of volumetric estimations of ammonia. Ammonia is decomposed by adding it to excess of sodium hypobromite, the excess of the latter being determined after addition of potassium iodide, by titrating the liberated iodine with thiosulphate.

The authors' results prove that this basis is not sufficiently accurate.

The Estimation of Acetone and of Ethyl Alcohol in a mixture of the two, by J. H. Bushill, B.Sc.

The object was to estimate these substances in comparatively small quantities in the products of fermentation by various bacteria. The method of estimating acetone by Rakshit was preferred to others. The method used by Northrop and his coworkers for estimating alcohol by oxidising with potassium dichromate and sulphuric acid was criticised. The author prefers to estimate the specific gravity of the mixture which, together with the acetone content, gives the alcohol present. For this, acetone gravity tables up to 1 per cent. had to be constructed.

A known volume was made slightly alkaline wth soda and distilled, the distillate being made to a definite volume. The gravity of this solution is then taken and

the acetone estimated. By means of the acetone tables the gravity of the acetone present can be found, and from this and the gravity of the mixture the alcohol may be estimated.

HYDROHEPATOSIS, A CONDITION ANALOGOUS TO HYDRONEPHROSIS.

By Philip D. McMaster and Peyton Rous.

Rockefeller Institute of Medical Research, New York.

Read before the Academy, Nov. 15, 1922.

The changes which follow obstruction to the common bile duct in human beings are highly various; and clinical and autopsy records yield few clues to the factors responsible for this diversity. We have attempted to come at them by animal experiment.

The fluid found in the distended ducts above an obstruction that has endured some time may be heavily loaded with bile pigment and mucus, green-black and tarry, or so wholly devoid of these constituents, despite a pronounced jaundice of the tissues in general, that it is colourless, limpid and watery. All gradations between such extremes are met with. We have shown in previous papers[1,2] that in the absence of infection all are traceable to the differing influences of the gall-bladder and ducts upon the bile first pent in the channels. The ducts elaborate a secretion of their own, which, thin and colourless, tends gradually to replace the bile; whereas the gall-bladder, by virtue of special abilities to concentrate the bile[2] and add mucus thereto, acts to fill the passages with one so thick and inspissated that the secretion just mentioned dilutes it but slowly and never replaces it perfectly. When the gall-bladder fails to exert its characteristic influences, as happens sometimes after injury to the organ, the fluid collecting in it, and in the ducts as well, is a colourless "white bile" similar to that contained in obstructed ducts unconnected with the *receptaculum felleæ.*

These are the findings after total obstruction. The changes taking place when the liver continues to secrete into the proper channels but against a pressure obstacle, have not only theoretical interest but a practical one as bearing upon the development of gallstones. We have studied them with the aid of a method whereby in dogs the common duct, and very probably the duct of any gland lying within the peritoneal cavity, may be permanently intubated and the secretion collected. The method depends upon the ability of the omentum to limit the spread of infection. When a rubber tube is connected with an intraperitoneal duct and led directly through the abdominal wall, it ordinarily comes away within a few days as the result of an ascending purulence. But if the tube be so bent upon itself that a considerable stretch of it, sheathed in omentum, is interposed between the duct and the exit wound, infection does not travel along it and it remains permanently in place. The pressure obstacle necessary to the observations was found, in some instances, in the tissue adhesions that developed about a balloon for bile collection which was interpolated in that part of the tube system lying within the abdomen. As the adhesions gradually thickened and contracted, they brought to bear an increasing resistance to the expansion of the balloon. In other instances, in which the balloon was placed outside of the animal in a basket moored to the skin, small gallstones forming in the lumen of the glass canula placed in the common duct interfered as they enlarged with the passage of the bile. Whichever the type of obstacle the same series of changes in the bile took place. From day to day, as the pressure against which the fluid was secreted became greater, it gradually lost the characters distinguishing it as bile. While still fairly copious, it contained less and less bilirubin, cholesterin and bile salts. Only faint traces of these substances were present in the last scanty specimens obtained before obstruction became complete. The final fluid distending the ducts was a " white bile " such as has already been mentioned, that is to say, no bile at all, in the ordinary sense of the term.

A comparison of the liver changes with those occurring in other glands after duct obstruction has proved enlightening. These changes have been best studied in the kidney. In this organ the pressure under which the retained secretion is held interferes with the venous flow—and it does this in the liver as well, a point which we have brought out in a previous paper.[3] Both organs continue to secrete; but the secretion is now turned back into the body. There is in both a progressive connective

tissue proliferation, and an accompanying parenchymal atrophy. The atrophy may become complete when only one kidney is affected; but when the outflow of urine from all o the renal tissue is interfered with death ensues long before the alterations progress so far. Similarly, obstruction of the bile ducts from but a portion of the liver leads to a complete parenchymal atrophy in the region concerned[4]; whereas if the common duct, which drains all of the organ, be occluded, the individual dies at a time when the hepatic changes are still relatively slight.

A striking early change in the kidney is sacculation, and the sac may come to contain several litres of a watery fluid devoid of the characters of urine—hence the name for the condition, *hydronephrosis*. Obstruction of the duct from the liver leads to a marked distention of the bile channels, but the organ itself does not bag out, a difference scarcely surprising when one considers that the maximum pressure developed upon biliary obstruction is extremely low (350 mm. of the bile itself, in the dog), whereas on renal obstruction it is high (from 650 to 900 mm., in terms of bile). The fact that the fluid ultimately found in the distended ducts from the liver has, in the absence of gall-bladder influence, none of the characters of bile, has been sufficiently indicated. When secretion takes place against a pressure obstacle there is a reduction both in the total output and in the percentage output of some substances, exactly as with the kidney.[5] Whether, as in the case of the latter organ, the percentage output of certain other substances is increased, remains to be determined.

From this comparison it will be seen that the changes consequent upon biliary obstruction and upon renal obstruction, respectively, are essentially similar in type. They are indeed the changes which follow obstruction to the ducts of glands in general; and the differences between the renal and hepatic manifestations of them are traceable merely to incidental peculiarities of the glands concerned. These facts would long ago have been recognised, were it not for the complicating activities during biliary obstruction of an extraneous organ, the gall-bladder. As indicating the essential likeness of the hepatic to the renal changes, we would suggest that the term *hydrohepatosis* be applied to the condition found after obstruction to the outflow of bile. When the contents of the obstructed ducts have been altered through the gall-bladder activity, the hydrohepatosis is *concealed*, in a very real sense; but when this has not happened, and the distended ducts are in consequence filled with "white bile," there is a *manifest hydrohepatosis*. But the terms have little importance as compared with the understanding that they are supposed to convey.

[1] *Rous, P., and McMaster, P. D., J. Exper. Med., Baltimore*, 1921, XXXIV., 47.

[2] *Rous, P., and McMaster, P. D., Ibid.*, 1921, XXXIV., 75.

[3] *Rous, P., and Larimore, L. D., ibid.*, 1920, XXXII., 249.

[4] *Nasse, Verhandl. deutsch. Ges. Chir.*, 1894, *Berlin*, XXIII., Pt. 2, 525.

[5] *Cushny, A. R., The Secretion of the Urine, London, New York, Bombay, Calcutta, and Madras*, 1917.

[Reprinted from the *Proceedings of the Academy of Sciences of the U.S.A.*]

CORRESPONDENCE.

THE HEAT OF FORMATION OF STIBINE.

To the Editor of THE CHEMICAL NEWS.

SIR,—I would like to point out that in nearly all the English textbooks on chemistry the heat of formation of Stibine for one molecule is given as -84.5 calories. This value was found by Berthelot and Petit (*compt. rend.*, 1889, CVIII., 546-550) from the heat of formation of the bromide

$$SbH_3 + 4Br_2 = SbBr_5 + 3HBr.$$

In 1908, however, A. Stock and W. Wrede (*Ber.*, 1908, XLI., 540-543) found the heat of formation of stibine by decomposing the gas quantitatively into its elements by an electric spark. The value they obtained for one molecule was -34 cals.

This latter paper appears to have been little noticed by English authors, for we find J. Thomlinson (*The Chemical News*, 1909, XCIX., 133) assuming the earlier value. His results are valueless in the light of the experiments of A. Stock and W. Wrede.

In most of the German textbooks on chemistry, the value -34 cals. is now taken instead of the previous one of -84.5 cals.—Yours, &c.,

EDWARD J. WEEKS, B.Sc., F.C.S.
The Sir John Cass Institute.
April 4, 1923.

NOTICES OF BOOKS.

Oxidations and Reductions in the Animal Body, by H. D. DAKIN, D.Sc., F.I.C., F.R.S. Second edition. *Longmans, Green & Co., London. 1922.* 6s. net.

It is eleven years since the first edition of this monograph appeared, and during this period much progress has been made in unravelling the mechanism of the various reactions which occur in the animal body. This advance has been general rather than specific, and accordingly the arrangement of the subject matter follows very closely that of the first edition, and it is only in dealing with the biochemistry of the carbohydrates that considerable alterations have been rendered necessary in order to incorporate the results of recent investigations. This monograph is devoted to the consideration of oxidation and reduction processes of the animal body, from the standpoint of the structure of the substances undergoing change. The purely biological aspects and also the thermo dynamics of the problems of oxidation and reduction have been omitted as being outside the scope of the work. The necessity for this intensive study of intermediary metabolism is justified owing to the developing appreciation of the fact that different proteins, fats, and sugars are not physiologically equivalent, and that certain definite chemical groups subserve special functions in the animal organism.

As the author points out, the oxidations and reductions occurring in the living body are so closely interwoven with other types of reaction, especially those involving condensation and hydrolysis, that their consideration, apart from other metabolic changes, is becoming unduly artificial, and will probably be abandoned in the near future. If this turns out to be so, we trust that the author will be chosen to give us that more extensive view of metabolic changes when the time arrives. The only blemish to be found in this monograph is the presence of a large number of small errors due to faulty proof reading and carelessness in setting up the type.

An excellent bibliography, and an index complete a book which we have no hesitation in recommending to all interested in biochemistry.

Vital Factors of Foods—Vitamins and Nutrition, by CARLETON ELLIS, S.B., F.C.S., and ANNIE L. MACLEOD, PH.D. Pp. XVII. + 391. London: Chapman & Hall, Ltd., 11, Henrietta St., W.C.2. 1923. Price 25s.

Not so many years ago it was believed that a balanced diet should contain protein, fat, carbohydrates, and certain salts in correct proportions, and then the animal body would continue to thrive. Great importance was attached to the calorie or energy value of foods.

To these, investigations of the past decade have added the essential inclusion of accessory food factors or vitamins.

It is, perhaps, surprising that substances which play so vital a rôle in nutrition should have escaped discovery for so long, but it is now definitely established at least three accessory factors are necessary, viz., the fat-soluble, growth-promoting Vitamin A, the water-soluble, anti-neuritic Vitamin B, and the anti-scorbutic Vitamin C. (Continued investigations may lead to the definite characterisation of a fourth.)

It has come to be realised that a number of maladies are not caused by the presence of toxins, as previously supposed, but by the absence of vitamins.

The authors have given a careful account of the discovery of the existence of these three vitamins and their specific functions. They have also indicated the different requirements of these in the food of children and adults.

Little is known at present concerning the chemical properties of the vitamins, and still less of their structure. The attempts of Funk and others to isolate pure vitamin are recorded. In this and other connections the original literature has been quoted and searched very thoroughly, so that all existing knowledge on the subject has been ably summarised.

Very few errors have been noted, but references are not quoted uniformly. This very minor defect will, doubtless, be re-

moved in the next edition, which should not be long in appearing.

In their comprehensive treatise the authors have dealt with the subject authoritatively in a lucid manner which cause the book to appeal to the general public as well as to scientists.

The Generation and Utilisation of Cold. A general discussion held by the Faraday Society. Pp. 136. London: The Faraday Society, 10, Essex Street, W.C. 1923. Price 10s. 6d.

From time to time the Faraday Society holds discussions upon physico-chemical subjects of both scientific and industrial interest. These deliberations are printed in the *Transactions* of the Society, but in order to give them a wider publicity the Society also issues them in the form of *Reprints.*

The present volume is an account of a general discussion on the Generation and Utilisation of Cold, which was held jointly by the Faraday Society and the British Cold Storage and Ice Association last October.

Part I. deals with the laboratory methods of Liquefaction. Prof. H. Kammerlingh Onnes has contributed an article on the lowest temperature yet obtained, and an account of the apparatus and methods adopted to attain low temperatures in the Leiden Cryogenic Laboratory is given by Dr. C. A. Crommelin; both contributions are fully illustrated. This, the more academical, portion concludes with a short paper on Ethyl Chloride, by Prof. C. F. Jenkins, and an account of the discussion on the laboratory methods of liquefaction in which a number of eminent authorities participated.

Part II. contains the contributions on the Industrial Methods of Liquefaction and the practical applications of low temperatures. After a general survey by K. S. Murray, follow papers by M. Georges Claude, E. A. Griffiths, A. J. Bremner, Dr. E. Griffiths and J. H. Aubery, and Cosmo Jones. All these contributions deal with some special aspect of technical importance.

The industrial importance of the achievements in this field can scarcely be over-estimated.

Laboratory Manual of Physical Chemistry, by ALBERT W. DAVISON and HENRY S. VAN KLOOSTER. Pp. VIII. + 182. London: Chapman & Hall, Ltd., Henrietta Street, W.C. 1922. Price 10s.

Lecturers in physical chemistry and laboratory demonstrators should find this manual both useful as a guide and helpful to indicate to students the exact apparatus needed for a given experiment and the method of arranging it.

In practical physical chemistry this is an advantage since it is seldom possible for all students to commence simultaneously with the same experiments.

Each experiment is set out in a clear and concise manner. The *object* is first stated, *references* are then quoted, frequently in three categories—textbooks, laboratory manuals and original articles. A list of *apparatus and chemicals required* comes next, and is followed by the *method of procedure.* There is then a blank scheme with instructions for entering *observations and measurements.* Finally the *calculations* required are indicated. Blank sheets and graph paper have been introduced, so that the manual can also serve firstly as a notebook and later as a reference volume.

As regards the experiments selected, these follow the usual lines, except that the procedures have been modified in many cases. Some of the methods have not appeared previously in textbooks.

Students who complete those described cannot fail to obtain a good general acquaintance with practical physical chemistry.

Messrs. The Eastman Kodak Company, of Rochester, N.Y., have orwarded us their fifth volume of *Abridged Scientific Publications*—now being published annually.

The 172 pp. have been filled with various papers compiled from research-records of the Kodak Laboratories, which were published in a wide range of scientific periodicals during the year 1921.

From the collection, one may judge that the science of photography will develop enormously during the next few years. L. Silberstein has included a most interesting paper upon the propagation of light in rotating systems, and S. E. Sheppard (very much in evidence throughout the volume)

criticises Mr. Renwick's theory that "it is . . . silver which first undergoes change on exposure to light" in discussing the contention that the highly dispersed silver halide is converted into a more condensed one.

It is to be regretted that various formulæ have been omitted from L. A. Sones' and C. E. Fawkes' paper upon the *Reduction of Developing-out Papers*, as the arguments and observations seem incomplete without them. Also, the experimental apparatus described on p. 75 seems a trifle vague, and could well do with more explanatory illustration than that on p. 81.

However, the work is admirably edited and printed. Perhaps, to render it more complete, the entire papers could well have been *inserted, instead of congests; and their sources kept free of the matter* by *including them in the contents-table.*

BOOKS RECEIVED.

Atomic Theories, by F. H. Loring. Pp. X. + 218. Second edition, revised. 1923. Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C.2. 12s. 6d. net.

Elements of Glass-Blowing, by H. P. Waran, M.A., Ph.D. Pp. VIII. + 113. 1923. Messrs. G. Bell & Sons, Ltd., York House, Portugal Street, W.C.2. 2s. 4d. net.

Wavelength Tables for Spectrum Analysis, by F. Twyman, F.Inst.P. Pp. VIII. + 106. 1923. Messrs. Adam Hilger, Ltd., 75a, Camden Road, N.W.1. 7s. 6d. net.

Bulletins issued by the *U.S. Department of the Interior, Bureau of Mines*:—

No. 218: *The Technology of Slate*, by Oliver Bowles. Pp. 132. Price 20 cents.

No. 201: *Prospecting and Testing for Oil and Gas*, by R. E. Collom. Pp. 170. Price 25 cents.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

7505—Coley, H. E.—Manufacture of barium sulphide and hydroxide. March 15.

7473—Spence, H.—Preparation of titanium compounds. March 15.

7407—Waterloo Chemical Works, Ltd.—Manufacture of ferric hydroxide. March 14.

Specifications Published this Week.

193881—Hybinette, N. V.—Separating, plating and refining of metals by electrolysis.

193894—Compagnie Francaise Thomson-Houston.—Production of boron and boron oxide for use in purifying copper castings.

171094—Pollak, Dr. F.—Manufacture of condensation products from fodmaldehyde and urea, thiourea, or their derivatives.

193912—British Cellulose & Chemical Manufacturing Co., Ltd., and Bader, W.—Treatment of cellulose acetate products.

193934—Accioly, F. De M.—Treatment of mineral and othed oils for the production of volatile liquids adapted for use as fuel.

193967—Hailwood, E. A.—Annealing lehr.

Abstract Published this Week.

192298—Alkaloids—Boehringer Sohn, C. H., and Stenzi, H., Nieder-Jngelheim-on-Rhine, Germanp.

Papaverine nitrite is prepared by the action of salts of nitrous acid on soluble salts of papaverine; the product is freed from papaverine by means of solvents such as benzene, toluene, tetrahydronaphthalene, or alcohol. The reaction may also be effected in the presence of one of the above mentioned solvents, examples of each method being given. The product exhibits the tissue dilating properties of its components in an enhanced degree.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3288.

CANADIAN CHEMICAL SUPPLIES.

THE EXPLOITATION OF CAPITAL.

Mineral secretions in the prairie districts have not, in the past, been regarded as sufficiently extensive to warrant the attention of industrial enterprise. Dr. Charles Camsell, deputy minister of mines, and Dr. A. W. G. Wilson, chief engineer of the mineral resources division, have now issued a report showing the activity in producing chemicals from the alkali deposits of Manitoba, Saskatchewan, Alberta, and British Columbia.

A few details showing the progress might be of interest. A plant costing $500,000.00 has been constructed at Dana, Sask. (the property of the Salts and Chemicals, Ltd.), and is operating upon the brines of the Muskiki Lake, 23 miles west of Humboldt. The estimated output of the plant is 30,000 tons of salt cake per annum, in addition to Epsom and other salts. The Bishopric and Lent Co. have founded a working at Frederick Lake, five miles south-west of Dunkirk, Sask. It is hoped, at a very early date, to produce 200 tons per day of salt cake; its present output being about 50 tons. An experimental plant has been devised for the Soda Deposits, Ltd., at Fusilier, Sask.; here exists a very pure deposit of sodium sulphate, some of which has already been shipped.

Other companies which are exploiting these districts are:—The Basque Chemical Co., at a lake 15 miles west of Ashcroft, B.C., for crude magnesium sulphate; and the Lillooct Soda Co., at a place 50 miles north of Clinton, B.C., for sodium carbonate.

Quoting from *Natural Resources*, published by the Department of the Interior, Ottawa: "The operations of these companies tend to bring before the public the possibilities of the western provinces in the mineral field, and should form the nucleus of the ever-increasing industry which, in time, should prove of great importance to the whole of Canada."

The Mines Branch of the Department of Mines, Ottawa, have organised a thorough investigation into the localities and extent of the unworked deposits, mainly for Glauber's salt, salt cake, Epsom salt, soda ash, and baking sodas. The secretions are believed to contain profitable amounts of magnesium salts, and acid sodium carbonate. The investigations are in charge of Mr. S. H. Cole, of the Department of Mines. J.M.

THE PROBLEM OF SUBSTITUTION IN THE BENZENE NUCLEUS AND THE THOMSON-LEWIS-LANGMUIR THEORY OF CO-VALENCE.

BY RONALD FRASER AND JAMES ERNEST HUMPHRIES.

The work of the organic chemists who have directed their attention to the problem of substitution in the benzene nucleus falls naturally under two heads: speculation on the mechanism of substitution and the study of the directive influence of substituents already present in the nucleus. The present paper deals only with the second part of the problem, though it is realised that the two are probably interdependent, and the possible effect of addition preceding substitution has been kept constantly in view.

Modern theories, as exemplified by the ideas of Lapworth, Fry, Vorländer, Prins, and Flürscheim,* agree in regarding orientation as occasioned by a differentiated condition—polarity or state of strain—of alternate carbon atoms. These theories inevitably bear among themselves a certain formal analogy, and the ideas here developed are no exception. They agree more particularly with those of Lapworth and Fry in possessing an electrical basis. Nothing is postulated, however, as to the constitution of the benzene nucleus, except that it is, of course, regarded as a six-membered ring; and we consider that the state of the molecule after the entry of a substituent and resulting from its pre-

* *The following references may be given to the papers of these authors: Lapworth, Mem. Man. Phil. Soc.*, 1920, LXIV., ii., 1; *T.*, 1922, CXXI., 416; *Fry, The Electronic Conception of Valence and the Constitution of Benzene*, 1921; *Vorländer, Ber.*, 1919, LII. (B), 263; *Prins. Chem. Weekblad*, 1918, XV., 571; *Flürscheim, J. pr. Chem.*, 1902, LXVI., 321; *ibid.*, 1905, LXXI., 497.

sence is the important factor in orientation (*cf.*, Mills, *J. Soc. Chem. Ind.*, 1921, XL., 417, R., in his review of Fry's monograph).

We have taken as our basis the Thomson-Lewis-Langmuir theory of co-valence, and on this foundation have built up an electronic interpretation of Lapworth's Principle of Induced Alternate Polarities, as already elaborated by Kermack and Robinson (*T.*, 1922, CXXI., 427). We are not prepared at the present stage to differentiate between the relative sizes of the octets surrounding positive and negative centres, and for our present purpose this appears to be of secondary importance. The development of the theory is based on the following three postulates. In order to avoid the introduction of unnecessary synonyms, we shall adopt in the sequel the terminology used by Kermack and Robinson (*loc. cit.*).

Postulate 1: The tendency of a disintegrated octet is towards further disruption; and of a nearly completed octet towards completion.

Postulate 2: The tendency towards octet stability of an atom with nearly completed octet is greater than the tendency to octet instability of an atom with disruption only incipient.

Postulate 3: The more nearly a group approaches octet stability, the greater the ease of replacement at that point.

It will be observed that Postulate 2 is simply a statement in terms of octets of the conclusion arrived at by Briggs (*T.*, 1908, XCIII., 1564; *ibid.*, 1917, CXI., 253; *ibid.*, 1919, CXV., 278), viz., that negative fields are in general stronger than positive gelds. Further, the relation of the carbon atom to Postulate 2 is of importance. It is generally recognised that carbon is unique in that it occupies the middle position in the first series of the periodic system, and is the first member of its group, containing the fewest number of electrons. It follows, then, that in a chain of carbon atoms of alternately positive and negative character, the positive centres tend to increasing positive character, and the negative centres to increasing negative character. Some interesting consequences of this element's electrical individuality will appear in the sequel.

Postulate 3 requires fnrther discussion. We are of opinion that the distinction between polar and non-polar compounds is merely one of degree, and our views in this respect are those of Briggs (*T.*, 1921, CXIX., 1879), and of Kermack and Robinson (*loc. cit.*). The extreme case of octet stability is evinced in compounds which have come to be known as polar, where an atom surrounded by a completed octet can actually exist free as an ion (*e.g.*, sodium chloride). There are evidently all gradations of octet stability from such extreme cases to those of typically non-polar compounds such as carbon dioxide, where octet stability is apparently only possible so long as there is electron-sharing among the octets. It is practically a universal rule that the reactivity of compounds, as measured by the velocity of reaction, is greater in the case of ionised than of non-ionised bodies, although some doubt is thrown on the complete generality of this statement by the work of Kahlenberg (*J. Phys. Chem.*, 1902, VI., 1; and subsequent papers. Compare, however, Stieglitz's discussion of Kahlenburg's results, *Qualitative Chemical Analysis*, Part I., 1912, pp. 84-87). Thus, although we do not anticipate ionisation as a cause of the reactivity of a substituent possessing a stable octet, we do, as a result of the consideration of the above gradation in reactivity, regard increasing octet stability as parallel with increasing likelihood of lability.

The Brown and Gibson Rule.

Of the many empirical rules which have been from time to time proposed to summarise the directive influence of substituents on an entering group, undoubtedly the best known is that of Brown and Gibson (T., 1892, LXI., 367). It was unfortunate that Brown and Gibson based at least part of their rule on the lack of knowledge of certain reactions (*cf.*, Holleman, *Bull Soc. Chim.*, 1911, IV., series 9, 1-14). Brown and Gibson based their rule on the oxidisability or otherwise of the compound HX, where X is the substituent, whereas the real basis of the rule is rather the tendency to oxidation or reduction of the substituent itself. On the electronic theory of oxidation and reduction, oxidation means loss of electrons, reduction gain of electrons. The ortho-para directive substituents listed by Brown and Gibson have in each case the atom which is linked to the nucleus in a state approaching octet stability, hence loss of electrons (*i.e.*, oxidation) is resisted (Postulate 1); while in the

case of the meta-directive substituents, viz., NO_2, COOH, SO_3H, $COCH_3$, the octets of N, C, S, C, are in a state of incipient disruption due to the effect of the negative (octet stable) O, $\begin{matrix}\cdot O\\ :O\end{matrix}$, O_3, OCH_3 respectively (*cf.*, Kermack and Robinson, *loc. cit.*): *hence loss of electrons (i.e.,* oxidation) is favoured (Postulate 1).*

In short, *negative (octet stable) substituents direct ortho-para: positive (octet unstable) substituents meta.*†

Fig. 1.

From the above argument the state of polarity of the carbon atoms in a mono-substituted benzene compound containing (1) an ortho-para directive substituent X (Fig. 1, a), and (2) a meta directive substituent Y *(Fig. 1, b) readily follows.* In Fig. 1, a, the octet of X tends to completion; hence the electrons shared with C_1 are drawn into X, making C_1 positive; C_2 can now appropriate electrons shared with the unstable system C_1, acquiring negative polarity; C_3 assumes positive polarity, and so on. In Fig. 1, b, containing Y in a state of incipient disruption, the polarities are obviously as shown (*cf.*, Lapworth, *Mem. Man. Phil. Soc.*, 1920, LXIV., ii, 1).

A consideration of the figures will show that whatever is the cause of ortho-para substitution in Fig. 1, a, will cause meta substitution in Fig. 1, b. The elucidation of these causes involves a special consideration of the position of hydrogen with regard to octet stability. We regard the condition corresponding to octet stability of hydrogen as represented by the nucleus with no electrons.* On this view, the hydrogen atom should be almost entirely lacking in a tendency to acquire an electron, and become the negative hydrogen postulated by Fry (*op. cit.*, pp. 20-27, p. 50). Our views receive strong support from the arguments of Stieglitz (*J. Amer. Chem. Soc.*, 1922, XLIV., 1293) against the existence of negative hydrogen in benzene compounds.

* CCl_3 *is listed by Brown and Gibson among the ortho-para directive substituents, by Vorländer (loc. cit.) among the meta-directive substituents. Spreckels* (*Ber.*, 1919, LII., B, 315) *has obtained the meta nitro compound under conditions which preclude hydrolysis. This is in complete agreement with the octet view, for the carbon atom in* CCl_3, *being attached to three negative (octet-stable) chlorines, is a positive centre, and hence falls into the meta-directive class. Cf., also below.*

It is convenient to note here the meta-directive nature of the ammonium salt group, as investigated by Vorländer and Siebert (*Ber.*, 1919, LII. [B], 233). *On nitrating* $C_6H_5N(CH_3)_3NO_3$, *for instance, the meta compound is obtained. It is evident that the condition of octet stability in* $C_6H_5\overset{+}{N}(\overset{-}{CH_3})_3\overset{+}{N}\overset{-}{O_3}$ *is as shown, the signs + and − indicating polarity as resulting from octet instability and octet stability respectively; the N atom attached to the nucleus being a positive centre, the whole group would be expected to direct meta.*

We might mention here that some of the ortho-para directive substituents, comprised of a side chain (Vorländer, loc. cit.), present a difficulty inasmuch as the induced polarity of the nucleus would appear to differ from case to case, as, for example, in $\cdot CH_2COOH$, $\cdot CH_2\cdot CH_2\cdot COOH$, $\cdot CH.CH\cdot COOH$, *all these groups, however, being ortho-para directive.*

† *Attention should be directed at this point to the use of the terms positive and negative applied to the groups mentioned, in view of the fact that in discussions on orientation the terms are used, arbitrarily and in general, with the opposite meaning. This has already been noticed by Davies* (*T.*, 1922, CXXI., *footnote to p.* 786). *The same writer* (*T.*, 1922, CXXI., 809) *disproves the statement made by one of us* (*Fraser, T.*, 1922, CXXI., 195) *that the directive influence of substituents was partly dependent on their volume. The statement above is now preferred.*

* *These remarks bring hydrogen (and the metals) into line with Postulate 2, which was stated in such a form as to make more obvious its application to the common organic elements, which lie to the right of the Periodic Table.*

The main consideration seems to be rather the state of the carbon atom to which the hydrogen is attached. In a carbon atom of negative polarity, the octet is comparatively firmly held; hence the hydrogen attached to it is to a great extent deprived of its electron; the converse holding with a carbon atom of positive polarity. Bearing in mind the unique position of hydrogen with regard to octet stability, it is evident that the hydrogen nuclei attached to negative carbon atoms are in a condition for ready substitution (Postulate 3).

Thus it is evident (Fig. 1) that the ortho-para hydrogens in Fig. 1, a, are in a condition for ready substitution, while in (b) it is the meta hydrogens which are the more easily replaced. It is seen that the essential difference between the two types of substitution is brought out with exceptional clearness on this view; and, further, the ortho-para directive influence of X on the one hand, and the meta-directive influence of Y on the other, is as it should be, independent of the nature of *the entering group.*

The special reactivity of the hydrogen in the para-position to an ortho-para directive substituent follows immediately from the above considerations, inasmuch as (Fig. 1, a), there is a reinforcing negative influence on the polarity of the 4-carbon atom.

Entry of Positive Groups.

It is well known that most of the radicles which can be introduced directly (*i.e.*, without the action of catalysts), into the benzene nucleus are positive (octet unstable). This follows at once from the preceding considerations. We have computed the number of electrons present in the typical positive radicles, COOH, SO_3H, and NO_2, with the following results: (1) COOH, charge + 1, has sixteen electrons available for the formation of octets; adopting the Hantzsch-Lapworth structure for carboxyl, it is found that the carbon atom contains only six electrons in the sheath, thus: $C \vdots \ddot{O} \vdots O : H$. If the group replace a hydrogen nucleus, the carboxyl carbon can readily complete its octet by sharing with the negative (octet stable) carbon atom in the nucleus, the octet of this atom being left complete by the removal of the hydrogen nucleus. (2) SO_3H. In sulphonation H_2SO_4 reacts as $OH-$ and SO_3H+; on this basis, the SO_3H radicle contains *twenty-four electrons available for octet formation.*

This leads to the structure $H:\ddot{O}:S \begin{matrix} \ddot{O}: \\ \ddot{O}: \end{matrix}$

in which the sulphur atom contains only six electrons in the sheath. (3) NO_2. In nitration, HNO_3 reacts as $OH-$ and NO_2; on this basis the number of electrons in the NO_2 radicle available for octet formation is eighteen; this leads to the structure $:N \begin{matrix} \ddot{O}: \\ \ddot{O}. \end{matrix}$

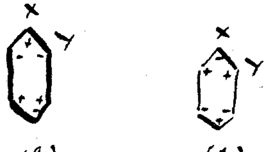
in which the unstable centre, N, again contains six electrons in the sheath. Similar arguments regarding the replacement of hydrogen apply to cases (2) and (3) as hold in (1).

It is clear that a negative (octet stable) substituent will not possess an electron content able to give the easy attainment of octet formation such as is possible in the cases cited above for positive substituents, and hence we should not expect the negative class to be so readily susceptible to direct introduction into the nucleus.

It is possible that we have here an underlying reason for the greater stability of compounds of the type (b) (see Fig. 1) than those of type (a) (*Cf.* Vorlander, *loc. cit.*).

The Holleman Series.

The relation between octet stability and *directive influence can now be discussed.* Consider a typical case of a di-substituted derivative, C_6H_4XY, where the octet stability of X is greater than that of Y.



(a) (b)

Fig. 2.

It follows from the relative stabilities of the octets of X and Y that the polarities of the carbon atoms should be as illustrated in Fig. 2 (a) rather than that shown in

(b). Generalising, it can be stated that the relative directive power of substituents follows a descending order of octet stability, and this seems to us to be the real implication of the Holleman series.

Holleman (*Die direkte Einfuhrung von Substituenten in den Benzolkern*, 1910, 466-469) points out that the directive tendencies of the commoner substituents follow the descending order: OH, NH_2, Cl, I, Br, CH_3, COOH, SO_3H, NO_2. The tendency to octet stability doubtless follows the descending order: O>N>C (*cf.* Briggs, *Phil. Mag.*, 1921, vi., XLII., 449-450); this accounts for the position of OH, NH_2, CH_3, it being remembered that the kernel octets are attached to positive hydrogen nuclei. The greater volumes of Cl, Br, I, agree with their comparatively low place in the series, increase in electropositiveness with increase in volume being a well established tendency which is readily interpreted electrically.* One would expect fluorine to be above hydroxyl in the series (see below). That all ortho-para directive substituents precede the meta follows from Postulate 2. Considering the meta-directive substituents among themselves, it is evident that electrons are more easily drawn from the labile carbon atom than from the more electropositive sulphur. The larger volume of sulphur as compared with nitrogen agrees with its high position, the effect of electropositiveness being here opposite to that obtaining in the ortho-para directive series.

All possible cases of the entry of the third group into a disubstituted derivative will now be considered.

In the disubstituted compouuds represented above, X_1 and X_2 are ortho-para directive (octet stable) substituents; Y_1 and Y_2 are meta directive (octet unstable) substituents.

Case 1: Fig. 3, i. The induced polarities of the carbon atoms is as shown in (a) and (b), according as the influence of X_1 or X_2 predominates. Since the inductive effects are opposed, there will be an equilibrium between the two electromers, as indicated above.

(*To be Continued.*)

* *The position of iodine relative to chlorine and bromine offers a curious anomaly. Owing to the differences of opinion existing with regard to the arrangement of electrons in the heavier atoms (Bohr,* NATURE, *1921,* CVII., 104; *Bury, J.A.C.S.,* 1921, XLIII., 1602), *we have not attempted to account for it.*

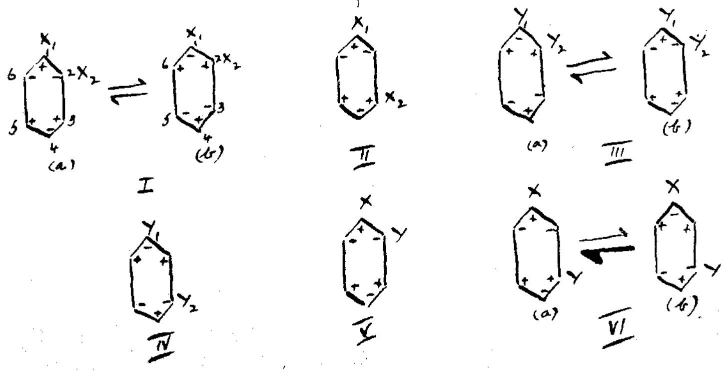


Fig. 3.

INTERVIEW WITH COMMERCIAL SECRETARY ON TRADE WITH POLAND.

Mr. R. E. Kimens, C.M.G., Commercial Secretary to His Majesty's Legation at Warsaw will be in attendance at the Department of Overseas Trade for one week, commencing on April 18. During that period he is prepared to interview by appointment United Kingdom manufacturers and merchants interested in trade with Poland.

Application for interviews with Mr. Kimens should be addressed without delay to the Comptroller-General, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. The reference, 4672 T.G., should be quoted in all applications.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY OF ARTS.

On Monday, April 16, the second Cantor Lecture on *Nitrates from Air* was delivered by E. KILBURN SCOTT, M.I.E.E., A.M.-INST.C.E.

On Wednesday, April 18, at the Ordinary Meeting, Mr. HAL WILLIAMS, M.I.MECH.E., M.I.E.E., M.I.STRUCT.E., gave a lecture on *Modern Abattoir Practice and Methods of Slaughtering*. W. Phené Neal, Alderman of the City of London, late Chairman of the Cattle Markets Committee of the Corporation, presided.

On Friday, April 20, at 4.30 p.m., there will be a joint meeting of Dominions and Colonies and Indian Sections. *A Review of the Base Metal Industry, with Special Reference to the Resources of the British Empire*, will be given by SIR RICHARD A. S. REDMAYNE, K.C.B., M.Sc., M.INST.-C.E., M.I.MECH.E., F.G.S.

The Rt. Hon. Lord Emmott, G.C.M.G., G.B.E., will preside.

THE GEOLOGICAL SOCIETY OF LONDON.

The following communication was read on March 28, *Further Researches on the Succession and Metamorphism in the Mona Complex*, by EDWARD GREENLY, D.Sc., F.G.S., Dr. Herbert H. Thomas, M.A., Vice-President, in the chair.

At the meeting held on Wednesday, April 18, the following communication was read: *The Structure of the Bowmore-Portaskaig District of Islay*, by JOHN FREDERICK NORMAN GREEN, B.A., F.G.S.

At the meeting to be held on May 2, PROF. J. JOLY, D.Sc., F.R.S., F.G.S., will deliver a lecture on *The Bearing of some Recent Advances in Physical Science upon Geology*.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the Ordinary Meeting in the Lecture Theatre of the Institution, Savoy Place, Victoria Embankment, W.C.2, on Thursday, April 20, 1923, a paper on *The Drive of Power Station Auxiliaries* was presented by L. BREACH, Member, and H. MIDGLEY, Associate Member.

THE FARADAY SOCIETY.

At a general discussion on *Alloys Resistant to Corrosion*, held jointly at Sheffield by the Faraday Society, the Sheffield Section of the Institute of Metals, and the Manchester Metallurgical Society, on April 13, the following papers were read:—

Heat and Acid Resisting Alloys, by J. FERDINAND KAYSER, ASSOC. MET.

A short account was given of the "heat and acid resisting" properties of nickel-chromium and nickel-chromium-iron alloys. Most of the literature dealing with this type of alloy has been of a commercial nature, and has contained grossly exaggerated claims concerning the high M.P., resistance to furnace gases, etc. Scientific literature on the subject is somewhat scanty.

The first alloys made in this country were binary alloys consisting of two parts nickel to one part of chromium. Although the addition of chromium to nickel lowers the melting-point until the percentage exceeds 58, alloys containing more than about 50 per cent. of chromium are almost impossible to cast on account of their extreme viscosity. There is nothing to be gained by the use of an alloy containing more than 35 per cent. of chromium. Furnace-parts, case-hardening boxes, etc., if made from a binary alloy, usually contain from 25 to 35 per cent. The alloys with lower percentages are used for resistance wire. Pure

nickel wire was formerly used for that purpose, but was far from satisfactory on account of its tendency to become brittle if used at temperatures above about 700° C. Addition of 10 per cent. of chromium completely prevents this, and nickel-chromium wire can be used at 1,000-1,050° C. without any appearance of brittleness.

The hardness of the alloys increases with increasing chromium, but before the alloys become so hard as to be useful for making a cutting tool, they become very brittle and break under the Brinell ball before showing a hardness higher than about 400.

The high cost of metallic chromium (approximately 5s. per lb.) soon led to the chromium being introduced as ferro-chromium. All alloys containing not less than 10 per cent. chromium together with not more than about 28 to 30 per cent. iron are equally resistant to oxidation, and the permissible percentage of iron depends upon the magnitude of the stress they will be called upon to withstand.

Besides iron, nickel, and chromium there are frequently considerable percentages of other elements present, the most important being carbon, silicon, aluminium, manganese, and copper.

Silicon is often added to nickel-chromium alloys, and up to 2 per cent. the physical properties do not appear to be much affected, but elaborate investigations concerning that point have not been made. The addition of 5 per cent. of silicon and upwards gives an intensely brittle and hard alloy. Such a high silicon also materially reduces the resistance of the alloys to the action of sulphur dioxide.

Nickel and aluminium form an intermetallic compound NiAl, characterised by a very great heat of formation and a melting-point higher than 1,700° C., *i.e.*, about 300° C. higher than the meltink-point of its most difficultly fusible constituent. When aluminium is added to a molten bath of a nickel-chromium, or nickel-chromium iron alloy, there is a violent endothermic reaction and a precipitate is formed. It may seem hard to detect a precipitate in an opaque liquid, but this is not difficult. The examination of microsections of samples quenched out in water from the molten state showed the presence of crystals of such a size and shape that they could not have formed in the solid state, and must have been present in the liquid.

Corrosion Resisting Properties.—Nickel-chromium alloys offer a perfect resistance to the corrosive action of the atmosphere in presence of hard, soft or sea water. Stainless steel should be correctly heat-treated and free from surface scale or pit marks. No heat-treatment is necessary in the case of nickel-chromium alloys. Name plates have been cast with the lettering in relief and exposed to atmospheric action after first sand blasting all over and then grinding the lettering only, and after several years are quite free from corrosion. In towns such name plates become covered with a greenish deposit, but this is identical with that found on window panes, etc., and can be removed as easily.

Samples to be tested were all weighed and measured beforehand. Samples of each alloy were in every case tested at room temperature and 100° C. The duration of the tests was varied for different rates of attack. When necessary, the samples were weighed both before and after the test, and from the loss of weight the rate of loss in grams per sq. metre per hour was calculated.

The alloys were all readily soluble in aqua regia, hydrochloric acid, and sulphuric acid, but not soluble in nitric acid.

Other acids tried were 20, 30 and 50 per cent. acetic, 30 per cent. citric, sulphurous, monochloracetic, and 75 per cent. phosphoric.

Monel Metal, by JOHN ARNOTT, A.I.C.

Monel metal may be said to be primarily an engineering material with excellent physical properties and good resistance to many corrosive agencies. Its sphere of use is therefore different from that of the truly acid-resisting metals, such as the iron-silicon alloys, which have to be employed in certain cases in spite of their poor mechanical properties.

Its composition and physical properties are fairly well known. Cold-rolled and cold-drawn metal are now used to quite a considerable extent.

An important property is its retention of strength and ductility at temperatures above normal.

At 750° F., the highest steam temperature in use in this country, money metal retains 85 per cent. of its strength.

Monel metal is very little affected by exposure to fairly pure air. A sheet freely exposed to the elements at Cathcart was bright after five months and showed no change in weight. In air which is most impure, it becomes discoloured, but the attack does not extend beyond the surface layers.

It is unaffected by wet, saturated or superheated steam. Sea water does not affect it.

Monel metal usually is not suitable for use with strong acids, as in acid manufacture. It is readily soluble in concentrated nitric acid, and is attacked by strong hydrochloric and sulphuric acids, especially if they are impure. Sulphurous acid, even when very dilute, attacked monel metal violently, leaving a deposit, largely consisting of sulphide.

Monel metal is not affected by alkalies and only to a slight extent by the majority of solutions of neutral salts at ordinary temperatures.

Monel metal is thus suitable for parts which have to resist (1) sea water, (2) impure water such as is found in many canals and in mines, (3) steam, (4) dilute acid solutions such as are used in many industrial operations, (5) alkaline solutions of all kinds.

The Mechanism of the so-called "Dry Corrosion" of Metals, by Ulick R. Evans.

Experiments on the behaviour of "apparently dry" metals, roughened with emery, show that no corrosion occurs when they are kept over sulphuric acid, and only slow, superficial corrosion when they are kept over water. The rate of attack is greatly increased by the presence of volatile electrolytes in the air, sulphur dioxide being most dangerous to iron and nickel, ammonia to copper and its alloys, and hydrogen chloride to zinc and aluminium; hydrogen sulphide and carbon dioxide somewhat increase the rate of rusting of iron, but produce only superficial changes on other metals. Contrary to popular belief, the corrosion of iron is not caused by the presence of ammonia. Corrosion of metals by volatile electrolytes appears to require the presence of some moisture, but proceeds in air which is distinctly unsaturated. Special phenomena occur at the contact of dissimilar metals, apparent electrochemical protection being observed in some cases.

The phenomena are best explained if we consider that electrochemical action occurs in the adherent (usually invisible) film of moisture. Volatile electrolytes increase the *conductivity* of the film and thus accelerate corrosion. Where they tend to produce hygroscopic corrosion-products, they bring about the absorption of further moisture and thus increase the *thickness* of the film; in several cases (zinc in hydrogen chloride, copper in ammonia, nickel in sulphur dioxide) the metal, originally dry, soon begins to shed liquid copiously, and in such cases corrosion is very serious.

The Resistance to Corrosion of Stainless Steel and Iron, by J. H. G. Monypenny, Chief of the Research Laboratory, Brown Bayley's Steel Works, Ltd., Sheffield.

To the almost exclusive use of stainless material for cutlery purposes over a considerable period may be ascribed the opinion that stainless steel has a definite composition and a small range of mechanical properties. There is, however, a whole range of steels in which the main variable is carbon, precisely in the same manner as this element is the prime factor in producing hard and soft steels. In addition to this the presence in varying amounts (either through accident or design) of other elements such as silicon, manganese, or nickel may have appreciable effects. Variations in one or more of these elements may have quite appreciable effects on the resistance to corrosion of the stainless material.

In addition to differences in chemical composition, the properties of the material may be profoundly modified by varying forms of heat treatment, and such variations have pronounced effects on the degree of resistance to corrosion.

Heat treatment—hardening, tempering and annealing—all influence the final products in various ways.

A study has been made of the resistance of stainless material to various corroding agents.

Tap water is without action on stainless steel, either hardened, or hardened and tempered. The author has had a number of small samples turned from a hardened and tempered bar over which tap water had been allowed to trickle for over twelve months, and there is not the slightest signs of attack. These samples are contained in a wide glass tube attached to a water tap, the latter being opened slightly, thus allowing water to trickle over the samples.

Samples of stainless steel and iron in the hardened and tempered condition were partly embedded in a block of wood and the latter then fixed to a jetty at a point between high and low water marks. The samples were thus alternately wet and dry. Ater six months they were quite bright and practically unattacked, there being only a few minute pits.

River and well waters have in general no appreciable action on stainless material. This is shown by the large number of pump

rods and other fittings which are in successful use in many parts of the country for pumping such water.

Ammonia, alkalies and alkaline carbonates in all strengths of solution appear to have no effect on stainless material.

It may be doubted whether the results of experiments in which samples of stainless steel (or any other metal) are placed or suspended in beakers containing solutions of various salts are of any great practical value. The results obtained simply refer to the conditions under which the test was carried out, and will vary as these conditions vary. With stainless material, when corrosion does take place, it almost invariably starts at the point of support, and often is entirely confined to that point. In such cases, therefore, the amount of corrosion, or even the presence or absence of corrosion, will depend on how the sample is supported. It is not intended, therefore, to give a list of how stainless samples behaved when immersed in various solutions. Speaking generally, it may be said that many such solutions have little or no effect on stainless material, and where corrosion does take place it proceeds much slower than with ordinary steel.

The results with solutions of a few salts, however, are of some interest.

Ammonium chloride solutions are well known as corroding agents. They have a staining and pitting action on stainless material the extent of which, however, depends on the concentration of the solution. With dilute solutions the attack is very slow, even when hot.

Ferric chloride solutions attack the steel even when fairly dilute (*e.g.*, 1 per cent.).

Copper chloride solutions also attack the steel. With strong solutions a deposit of copper is formed, and the steel is eaten away fairly rapidly. With dilute solutions, on the other hand, pitting takes place and very little copper is deposited.

Copper sulphate, nitrate, and acetate solutions, on the other hand, have no action on the steel. The presence of copper sulphate also appears to retard greatly, and in some cases to prevent the attack of dilute sulphuric acid on stainless material.

Hydrochloric and sulphuric acids attack stainless steel or iron rapidly. The action of these acids on high chromium steels has been known for a considerable time, and hence it is not necessary to devote further attention to them. Sulphurous acid also attacks stainless material, probably to some extent owing to the presence in it of sulphuric acid.

Nitric Acid. — The attack of nitric acid present several interesting features. Very dilute solutions attack stainless material slowly, the rate of attack decreasing with increasing content of chromium, and with decreasing carbon content. The stronger acids used in analytical work (*e.g.*, S.G. 1.20 and 1.42) are practically without action on the steel. This fact appears to be fairly known, and since acids of S.G. 1.20 attacks ordinary steel very rapidly this reagent is useful should stainless material be accidentally mixed up with ordinary steel. With prolonged attack (*e.g.*, lasting a month or six weeks) of acids of these strengths, the surface of the steel is coloured a purplish tint but there is no appreciable alteration in weight. The colour thus produced bears some resemblance to a " temper colour," and is probably of a similar type to the latter. If a polished microsection be treated in this way, it is found that the background is coloured while the carbide remains brilliantly white.

With a typical stainless steel containing 0.32 per cent. carbon and 12.2 per cent. chromium the maximum attack with dilute acids (at atmospheric temperatures) occured at about normal strength.

ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on April 20, at 9 o'clock, will be delivered by W. J. S. LOCKYER, M.A., F.R.A.S., Director, Norman Lockyer Observatory. The subject is *The Growth of the Telescope.*

On Tuesday, April 17, SIR ARTHUR KEITH, M.D., LL.D., F.R.S., Sec. R.I., Fullerian Prof. of Physiology, gave a lecture on *The Machinery of Human Evolution: How Old Structures are Lost.*

On Thursday, April 19, PROF. A. O. RANKINE, O.B.E., D.Sc., lectured on *Transmission of Speech by Light.* (Lecture II.).

At a General Meeting of the members of the Royal Institution, held on the 9th inst., the Duke of Northumberland (President), in the chair, a resolution of condolence with Lady Dewar on the death of Sir James Dewar was moved by the President and carried unanimously.

Mr. Arrol Moir, Professor A. O. Rankine, Lady Wallace, and Miss Williamson were elected members.

SOCIETY OF GLASS TECHNOLOGY.

The Sixth Annual General Meeting of the Society was held in Sheffield, on Wednesday, April 18, 1923.

After other business, the Presidential address, entitled, *The Year in Review in the World of Glassmaking*, was delivered.

Afterwards a general discussion on *Works Organisation*, opened by a paper entitled *Organising for Production from Pot Furnaces*, by W. W. WARREN, A.M.I.C.E., A.M.I.E.E. Other speakers presented the case for Tank Furnace Works.

FIFTH ANNUAL DINNER.

The attention of members is directed to the fact that the Fifth Annual Dinner of the Society will be held this year in London, following the meeting on May 16.

Members are requested to keep this date open so that a good attendance may be assured. Full particulars will be announced later.

THE CHEMICAL SOCIETY.

At the Ordinary Scientific Meeting, on Thursday, April 19, the following papers were read:—

The Influence of Nitro-groups on the Reactivity of Substituents in the Benzene Nucleus. Part VII. Reactions of 2:5- and 4:5-dinitro-m-xylenes, by K. IBBOTSON and J. KENNER.

The Chemistry of the Three-carbon System. Part I. The Influence of the cyclo*hexane ring on the αβ-βγ Change*, by S. F. BIRCH, G. A. R. KON, and W. S. G. P. NORRIS.

On the promotion of Catalytic Reactions. Part I., by S. MEDSFORTH.

PHYSICS AND SEWAGE DISPOSAL.

At a meeting of the Birmingham and Midland Section of the Society of Chemical Industry, on Tuesday, April 10, this subject was discussed in an important paper by Mr. F. R. O'SHAUGHNESSY, A.R.C.Sc., F.I.C., Consulting Chemist to the Birmingham, Tame and Rea District Drainage Board.

The paper was a thesis dealing with the physical properties of the principal components of normal sewage (*i.e.*, of the water on the one hand and the usual polluting bodies on the other) as affecting those operations preliminary to disposal, comprised under the heading of "Treatment," which are of a preparatory character and for the purpose of facilitating disposal.

To this end the published work of a number of leading experts is critically reviewed in support of the views advanced by the author.

A clear distinction is made between "Treatment" and "Disposal."

Emphasis is laid on a statement of Fowler's, viz.: "The subject of sewage disposal is mainly a question of the separation of solids from liquids."

This separation has been difficult because of the physical character of much of the solid matter present in sewage, viz.: its colloidal or gummy character, which causes it to adhere tenaciously to water.

The author refers to his own published results, showing:—

That fæcal solids pass into colloidal solution in water by agitation to 200-250 parts per 100,000;

That this is the chief source of colloidal solids in normal sewage;

That the amount varies in different sewages.

The effect of various methods of treatment of sewage are discussed: Simple sedimentation, chemical precipitation, biological action (anærobic and ærobic). It is shown that whereas the visible suspended solids in sewage are for the most part readily separated, the bulk of the colloidal solids are held very tenaciously by the water of the sewage.

The colloidal solids are very partially thrown down by simple sedimentation. Chemical precipitation effects only partial removal even when large amount of chemicals are added, and when in moderate amount improves the liquor for the bacteria bed. Anærobic action, whilst removing colloids, makes the liquor very offensive; ærobic treatment is the only means of precipitating colloidal solids whilst leaving the liquid in a satisfactory condition.

It is known that as æration is effective and complete so the rate of removal of these troublesome solids is also effective.

That considerations of this character and the observed suddenness with which they are brought down in the top of a percolation bed suggest that, given an appropriate

agent, their removal should be easy and rapid.

The remarkable work of F. Wallis Stoddart, F.I.C., F.C.S., is reviewed, which indicated that given a limpid sewage liquid which had been freed from colloidal solids by appropriate means, the quantity of liquid which could be put through a suitable percolation bacteria bed might be immensely increased, even to 10 or 20 million gallons per acre. The author then indicates that the technique provided by Messrs. Ardern and Lockett in the activated sludge process has furnished the key to the solution of this problem. That a modified use of this technique which for purposes of distinction the author proposed to call the flocculated sludge process, is the appropriate means of dealing with colloidal matter in solution.

In regard to the activated sludge proposition, the merits and demerits are discussed. Advantages are: Completion of sewage purification in one tank in one operation; elimination of nuisance, reduction of area, and production of valuable ertiliser.

The objects are: Existing works discarded; sludge problem more complex; economical recovery of sludge problematical; extravagant, *i.e.*, prolonged æration, high oxygen demand by sludge, alteration of physical character of sludge, etc.; slow rate of solution of oxygen in water the central physical fact here; in many cases protection required for æration. The procedure in this process is arbitrary, its objective largely commercial (conserving manurial elements) and must stand or fall on financial merits.

As to flocculated sludge process (a modification of the activated sludge process), three operations are involved: Agitation of sewage and flocculated sludge with air for a time to bring about clarification of the sewage and partial purification of the liquor; separation of sludge from treated sewage, and re-æration of separated sludge.

This mode of procedure may be applied to the whole sewage (less grit, etc.) as in the activated sludge process or after any desired degree of preliminary sedimentation. The advantages are: A wide choice of procedure is available, for the process may be incorporated with existing plant; greatly increased volumes of liquid may be put on bacteria beds; nuisance (odour and flies) may be eliminated; and the expensive æration period may be reduced to reasonable proportions.

The theory of flocculated sludge process is next discussed. Evidence is given that the purification of sewage is effected by two distinct means: By physical agents which bring about flocculation of colloidal solids; and by biological agents which bring about oxidation of the dissolved impurities. In the activated sludge technique the real flocculating agent is the sludge. Evidence is given that the condition of the sludge is much more important than its quantity, and that with the procedure advocated in the flocculated sludge process very remarkable and rapid purification may be obtained with greatly reduced volume of sludge. Thus the flocculated sludge is apparently the vehicle for the transference of energy. By eliminating easily separable material from the sewage the oxygen demand of unprofitable or useless elements is reduced and consequently the efficiency of the action very greatly increased.

The whole question of sludge treatment is presented thus:—

The bulk of the solids may be separated from the bulk of liquid in the crude sewage quite readily.

When separated, the peculiar physical properties of the solids assert themselves thus: (*a*) The solids (sludge) adhere most tenaciously to about 9 times their weight of water; (*b*) the sewage liquor adheres with great tenacity to about 20-25 per cent. of the solids of the original sewage.

The problem presented in each case is the same, viz.: the modification of the physical character of the colloidal solids.

In the case of the sludge this change is conveniently effected by the inoffensive intensive, anærobic digestion of the sludge as by the Imhoff Tank or by the method of separate digestion as at Birmingham (England), and Baltimore (U.S.A.), and elsewhere. It is claimed that the cost of the latter method is relatively low.

NOTE ON THE PREPARATION OF SARCOLACTIC ACID.

By John Missenden, B.Sc.

This substance, also known as δ-α-hydroxypropionic acid, δ-α-$CH_3.CH(OH).CO.OH$, may be prepared from proteinous tissue, mainly intercostal, by boiling the flesh for several hours until the fibres separate and present a greyish appearance. The liquid so obtained, subsequent to filtration, is fairly abundant in sarcolactic acid, and should be carefully evaporated to a thick syrup, care being taken that no burning on

the sides of the vessel takes place. Immersion of this vessel in strong brine is a satisfactory process.

While at a temperature of about 40° C., 2.5 volumes of alcohol (75 per cent.) should be added, and the whole made up to 6 volumes with water. Again, the evaporation to a syrup takes place, and the whole is slightly acidified with a few drops of sulphuric acid, and filtered. The acid is then extracted with ether, and purified by conversion into a convenient metallic salt.

This method of preparation takes several days, but seems the speediest way of obtaining the pure product. There is no objection to assisting the filtration of the acidified extract by the careful addition of water, but subsequent procedure makes this undesirable. Muscular tissues surrounding the abdomen and femur in the human body form a plentiful source of the substance, but the regions of the lactic organs at the front of the thoracic cavity yield the best supply.

GENERAL NOTES.

DYESTUFFS (IMPORT REGULATION) ACT.

APPLICATIONS FOR LICENCES IN MARCH.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during the month of March, 1923, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 539, of which 459 were from merchants and dealers. To these should be added the 30 applications outstanding on 1st March, making a total for the month of 569. These were dealt with as follows:—

Granted.—405 (of which 376 were dealt with within seven days of receipt).

Referred to British makers of similar products.—105 (of which 96 were dealt with within seven days of receipt).

Referred to Reparation supplies available.—37 (all of which were dealt with within two days of receipt).

Outstanding on 31st March. — 22 (mostly received immediately prior to Easter).

Of the total number, 569, of applications received, 467, or 82 per cent., were dealt with within four days of receipt.

IMPORT OF CHEMICALS INTO GUATEMALA.

The Acting British Vice-Consul at Guatemala reports that by virtue of an Ordinance, dated 30th December, 1922, and published in the "Official Gazette" of 23rd January last, certain chemical and medicinal substances may be imported by persons not licensed as pharmacists or druggists.

A list of such chemical and medicinal substances is available and may be consulted by United Kingdom firms interested on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference 7683/F.L.).

ECLIPSE TESTS.

FURTHER CONFIRMATION OF EINSTEIN'S THEORY OF RELATIVITY.

The photographs of the total eclipse of the sun last September have now been carefully examined and measured. Compared with their real positions, the stars thus photographed near the eclipsed sun all showed the displacement which should appear, supposing Einstein's theory to be true.

Close on the announcement that the Canadian plates show practically the Einstein shifts comes news from the Lick Observatory of similar confirmation. The Lick expedition, which went to Australia, was very elaborately equipped for the purposes of the test, and obtained a series of photographs of the region around the eclipsed sun which showed over eighty stars, some of them as faint as the tenth magnitude. The mechanical work of measuring the plates for star positions, which necessitated determining them with accuracy to a small fraction of a second (or on the scale of the plates to about the 5,000th part of an inch), and the mathematical discussion of the actual values of the displacements has taken several months.

Thus Relativity has successfully survived the two eclipse tests to which it has been subjected, that of 1919 and that of last year.

NOTICES OF BOOKS.

Atomic Theories, by F. H. LORING. Second edition, revised. Pp. XII. + 218. London: Methuen & Co., Ltd., 36, Essex Street, W.C.2. 1923. 12s. 6d. net.

During the last few years, atomic and sub-atomic science has developed so greatly that only the specialist has been able to keep well-informed by careful and constant perusal of the original literature. Mr. Loring's volume on the atomic theories has therefore been of great service for the general scientific reader anxious to gain a clear, comprehensive, and up-to-date knowledge of this subject.

The author has availed himself of the opportunity afforded by the publication of a second edition to introduce the results and conclusions of investigations which have been announced since the first edition (reviewed in *The Chemical News*, 1922, CXXIV., 158) appeared.

It may be pointed out that the tetrahedral arrangement of the carbon atom given in Fig. 19, page 90, is not adhered to on page 110, Fig. 33. Presumably the author had in mind that the electrons might shift their positions in the carbon atom to meet the positions in the attached oxygen atoms. The tetrahedral arrangement in the carbon atom would obviously do equally well, for one oxygen atom need only be orientated accordingly.

The additions include the author's *Wedge Periodic Table of the Elements*, and a fuller table of isotopes is given on pages 191 and 193.

A few minor corrections have also been made, and difficult passages re-written, so that the book can now claim to be a standard work, since it deals with all the theories relating to the atom, and discusses their experimental foundations. It will be read by an increasing number of students of Chemistry and Physics, and by others interested in the latest developments and views concerning the Atom.

Surface Tension and Surface Energy, and their Influence on Chemical Phenomena, by R. S. WILLOWS, M.A., D.Sc., and E. HATSCHEK. Third Edition. Pp. VIII. + 134, with 25 illustrations. London: Messrs. J. & A. Churchill, 7, Great Marlborough St. 1923. 6s. 6d. net.

The exposition of main physical properties of the subject, together with absence of a quantity of tedious calculation seems to be the keynote of this edition; in which has been added some important notes upon the properties of thin films, polarised molecules, and boundary lubrication. As Dr. Willows explains in his preface, the work indicates the possible connections between surface tension and other chemical and physical properties of liquids, "and . . . opens up many fascinating avenues for research."

Some confirmed observations of Eötvös, the Hungarian chemist, have been dealt with, in order to show how these relationships are more or less apparent, and the evolution of Dr. A. Ferguson's formula (*Phil. Mag.*, Jan., 1916), $\sigma_\theta = \sigma_o (1-b\theta)^n$ for showing the dependence of surface tension upon critical temperature is of interest. On p. 123 is a brief paragraph incorporating some points upon the various stages of tanning, and their facilitation by means of the electric charge (*i.e.*, the electro-combination of the tannins).

The work is an old favourite, and the present edition should prove of even greater value to biologists and chemists. We can well recommend it to those engaged in the study of colloidal principles.

The Spectroscope and its Uses in General Analytical Chemistry, by T. THORNE BAKER, A.M.I.E.E., F.R.P.S. Second Edition. Pp. X. + 208. London: Messrs. Baillière, Tindall & Cox, 8, Henrietta Street, Covent Garden, W.C.2. 1923. 7s. 6d.

The vast development of spectroscopy has been responsible for considerable extensions in this work. In 1907, when the first edition was issued, the spectroscope was not sufficiently developed to render it so highly important in quantitative analytical processes, although its efficiency was fully recognised. Now, the most modern instruments and their most recent applications have necessitated much of the text being recast.

Laboratory usages have been dealt with in an extensive manner, spectrophoto-

graphy taking prominent space. The book would hardly be complete without giving details of the infra-red spectrometer of Messrs. A. Hilger, Ltd., which the author has described and illustrated in a manner clearly demonstrating the fundaments of series-reflection-refraction through the thermopile-slit.

In the final chapter, attention is paid to the X-ray spectra. The examination of metals by this means has produced some new results which are discussed throughout the brief treatise upon the subject; but greater attention could have been paid to the monochromatic-radiation filters, which must vary with the substance examined, and the nature of the anti-cathode target.

Good illustration (for which Messrs. A. Hilger, Ltd., Watson Sons, Ltd., and J. J. Griffin & Sons, Ltd., are largely responsible) and compositorial excellence crown a very lucid and self-explanatory text; a most useful work in every way.

We are in receipt of *Skinner's Cotton Trade Directory for* 1923. (London: Messrs. Thomas Skinner & Co., Gresham House, London, E.C.2. Price 12s. 6d. net). It is a handy and compact volume, and contains much information of value to those interested in the personnel and progress of the cotton industry.

The *proprietors of Current Opinion* (The Industrial League and Council, 82, Victoria St., London, S.W.1) have sent us their "first birthday" number. The general tone of the publication tends to be optimistic of trade revival, and figures are quoted which justify the optimism. There is little doubt that such periodicals as *Current Opinion* help greatly in the co-ordination of individual enterprise, and we wish the proprietors and editor, G. C. Lawrence, Esq., every success.

The issue of *Nature* for April 7 contains *further correspondence relating to the discovery and identity of Hafnium.*

In a letter *On Urbain's Celtium Lines*, H. M. Hansen and S. Werner, of *Universitetets Institut for teoretisk Fysik, Copenhagen*, write:

Through an examination of the very careful measurements of the spectra of the rare earths published during the last few years by Eder, we have learned in the meantime that the greater part of Urbain's celtium lines have been observed by this author (*Wiener Ber.*, IIa, vol. 124, 1915) in the spectrum of a preparation of the rare earth element cassiopeium or lutetium. The discovery of this element (atomic number 71) was announced in 1905 by Auer von Welsbach, to whom the former name is due, while the name lutetium was proposed in 1907 by Urbain, who published at the same time the first list of lines of its optical spectrum (*Comptes rendus*, t. 1907, 145, p. 759).

In the table they give the wave-lengths of the celtium lines from Urbain's paper and the corresponding wave-lengths and intensities from Eder's measurements of the cassiopeium spectrum.

There is close accordance in the values of the relative intensities in the two cases, which we think justifies the identification of the lines also in the few cases where the difference between the wave-lengths is slightly greater than is to be expected from the usual accuracy of Urbain's measurements of wave-lengths or rare earths. Only a few of these lines, denoted by an asterisk, were included in Urbain's original list of the lutetium lines.

It is of interest to add that in a recent note (*Comptes rendus*, t. 176, 1923, p. 496), which first came to our notice after the above was written, dealing with the discovery by Coster and Hevesy of the element hafnium with atomic number 72, Urbain himself directs attention to the particular behaviour of the lines ascribed by him to celtium, and expresses the conjecture that these lines—the observation of which was the basis for his belief in the presence of a new element in his preparation—may actually constitute the spark spectrum of the element 71.

D. Coster and G. Hevesy also contribute another letter *On Celtium and Hafnium.* Among other matters they state:

Only two lines of the element 72 were claimed to have been detected by Dauvillier, and even in the case of the most intense of these lines we meet with the difficulty that it falls in the same place in the spectrum as the strongest zirconium line in the second order. As an argument against ascribing this line to zirconium, Urbain states that the optical spectrum of his preparations did not show any zirconium line. An investigation of Urbain's spectrum of the "celtium" preparation, however, does not show any line of the hafnium spectrum either. If the possibility of the presence of one of these elements in Urbain's preparation can be taken seriously into consideration, it should be expected that zirconium would be present in greater amount. In

fact, zirconium was likely to be more abundant in the original mineral than hafnium, and a purification of rare earth preparations from zirconium and not simultaneously from hafnium, by treating with oxalic acid or any other method mentioned by Urbain, is scarcely imaginable in view of the close similarity of the chemical properties of these elements. As mentioned in our previous letters, however, the two lines ascribed by Dauvillier to the element 72 were lying 4 X-units distant from our Hf-lines, which is distinctly more than the limit of experimental error,[1] whereas the lines of the elements 70 and 71 measured by Dauvillier (*Comptes rendus*, vol. 174, p. 1347, 1922) on the same plates closely agree with the measurements of the same elements obtained by Coster (*Phil. Mag.*, vol. 44, p 546, 1922). As the two lines according to Dauvillier were extremely faint, they may easily be explained to be of some other origin.

It is of interest to note that, at various times, announcements have been made as to the complexity of zirconium. In 1845 Svanberg claimed that in decomposing zircons he discovered a new element, "norium," with a lower atomic weight than zirconium. His and Sjögren's (1853) statements were later disproved by the work of several investigators, including Marignac. In 1864 Nylander reported the existence of two earths in zircona. Five years later, by a spectroscopic investigation of zirconium, Sorby was led to announce the discovery of "jargonium" and Church of "nigrium." Finally, in 1901, Hofmann and Prandtl thought that they had found in euxenite a new element related to zirconium. It is also interesting to note that Mendeleéff, as we learn from Sir T. E. Thorpe's letter in *Nature* of February 24, p. 252 (March 17), suggested that the extraordinarily discordant values for the atomic weight of titanium, found by several chemists, might be due to the presence of a homologous element of higher atomic weight in their material. Whether these statements in some cases may be explained by the presence of hafnium in the minerals and preparations under investigation, it is not easy to decide. The intricate chemistry of zirconium, and the great chemical similarity of hafnium with this element, would in fact have made any establishment of hafnium very difficult before the development o fthe powerful method of X-ray analysis.

[1] *Dauvillier's measurements carried out since the announcement of our discovery, on other material which possibly contained hafnium, have already led him to give new values for the same wave-lengths, which are respectively* 3.4 *and* 2.3 *X-units larger* (NATURE, *February* 17, 1923).

A Tested Method of Laboratory Organisation, by SEYMOUR PILE, M.A. (CANTAB), and REGINALD G. JOHNSTON, with an introduction by W. R. BARCLAY, O.B.E. Pp. XI. + 98. London: H. F. & G. Witherby, 326, High Holborn, W.C. 1923. 7s. 6d. net.

Birmingham brass-founders followed a commendable course when they entered upon their co-operative laboratory scheme, and put into being the Midland Laboratory Guild, Ltd. The hundreds of little brass-works in and around the district were sadly lacking in efficient laboratory services until this great centre was established; now they have facilities at least equal to those possessed by the enormous steel firms of Lancashire and Yorkshire.

Such a laboratory needs first-class organisation, and Messrs. Pile and Johnston have described in their book how this has been attained. Not only the construction and equipment of the building have been dealt with, but also the personnel and the methods of analysis and costing; and the masterly manner of enumeration tells of considerable familiarity with the inner detail of the processes.

The chapter upon *The Scientist in Relation to This, That, and the Other* is something unusual. It takes the scientific mind to pieces, exposing all the works. Some of these works, reduced to their first principles, are a trifle astounding, as they typify the scientist on the lines of human perfection, and give one the impression that the analytical chemist is the nearest approach to the ideal. This has the effect, as do most other chapters in the book, of creating an inspiring atmosphere around the study of chemistry, and promoting what is essential to the scientist—a love for his work.

Altogether, the book must prove valuable. The methods it describes are efficient, and will have some significant bearing upon future laboratory management; while, as a text-book, it provides excellent scope for the foundation of new ideas. Messrs. Pile and Johnston are to be congratulated upon it, and wished every success.

We have received a copy of the 1923 issue of the *Directory of Paper Makers of the United Kingdom*, price 5s. 9d. net. It has again been authentically revised and brought up to date, and contains information valuable to all connected with this industry.

It includes alphabetical lists of paper makers; paper enamellers, surfacers and gummers; mills; trade designations; paper trade customs, and other useful matter.

The following Bulletins have been published by the Department of the Interior, United States Geological Survey:—

Gold and Silver in 1921, by J. P. Dunlop.

Stone in 1921, by G. F. Loughlin and A. T. Coons.

Cement in 1921, by Belle W. Bagley.

Natural Gas Gasoline in 1921, by E. G. Sievres.

Potash in the Greensands of New Jersey, by George Rodgers Mansfield (1922).

Surface Water Supply of the United States, 1918. *Part IX.: Colorado River Basin.*

Copper Deposits of the Tyrone District, New Mexico, by Sidney Paige, 1922.

BOOKS RECEIVED.

Ink, by C. Ainsworth Mitchell, M.A., F.I.C. Pp. VIII. + 128. 1923. Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. 3s. net.

Einfuhrung in die Kolloidchemie, von Prof. Viktor Poschl. Pp. XII. + 158. 1923. Verlag von Theodor Steinkkopff, Dresden und Leipzig. 3s. 11d. net.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

7828—Deschamps, J. J.—Facilitating physical or chemical reactions in piled bodies. March 19.

8120—Farbenfabriken vorm., F. Bayer & Co.—Manufacture or azo-dyes. March 21.

7813—Verein fur Chemische und Metallugische Produktion.—Production of chemically-pure hydrochloric acid. March 19.

Specifications Published this Week.

194339—Eardt, H.—Process for precipitating or recovering metals from their solutions.

194625—Douglas, R. P.—Manufacture of sulphate of ammonia.

185124—Mathesius, W., & H.—Process for producing lead alloys containing strontium.

Abstract Published this Week.

192438—Dyes; intermediate products.—Akt-Ges fur Anilin-Fabrikation, Berlin.

o-Oxyazo dyes are prepared by coupling a diazotized dihalogen-2-aminophenol, containing as a fifth substituent a halogen atom or an alkyl group, with an oxynaphthalene sulphonic acid or a substitution product thereof other than 8-halogen-1-oxynaphthalene-5-sulphonic acid. Examples are given of the preparation of dyes from the following pairs of components:—3: 4: 6-trichlor-2-aminophenol and 1-naphthol-5-sulphonic acid; 3: 4: 5-trichlor-2-aminophenol and 1-acetylamino-8-naphthol-4-sulphonic acid; 3: 4: 5: 6-tetrachlor-2-aminophenol and 2-naphthol-6-sulphonic acid; 4-methyl-3: 5-dichlor-2-aminophenol and 1-acetylamino-8-naphthol-4-sulphonic acid; these dye wool with chrome mordants reddish-blue, blue, reddish-violet, and reddish-blue shades respectively. The following second components also are specified: — 1-naphthol-4-sulphonic acid, 1-amino-8-naphthol-4-sulphonic acid, 1-amino-8-naphthol-2: 4-disulphonic acid, 1-benzoylamino-8-naphthol-4-sulphonic acid, 1 -*p*- toluenesulphamino-8-naphthol-4-sulphonic acid, 1-phenylamino-8-naphthol-3: 6-disulphonic acid, 2-benzoylamino-5-naphthol-7-sulphonic acid. Specification 168,681 is referred to.

3: 4: 6-*Trichlor-2-aminophenol* is made from 1: 2: 4: 5-tetrachlorbenzene by replacing one chlorine atom by an hydroxyl group, nitrating, and reducing.

3: 4: 5-*Trichlor-2-aminophenol* is made from 3: 4: 5-trichloraniline by diazotizing, boiling, nitrating, and reducing.

4-*Methyl*-3: 5-*dichlor-2-aminophenol* is made from 4-amino-2: 6-dichlor-1-methylbenzene by diazotizing, boiling, nitrating, and reducing; the 4-amino-2: 6-dichlor-1-methylbenzene is prepared by dichlorinating 4-nitrolouene and reducing.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the price of 1s. 6d. each.

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THE CHEMICAL NEWS,

VOL. CXXVI. No. 3289.

CHEMICAL INDUSTRY AND THE BRITISH EMPIRE EXHIBITION (1924).

For the first time in the history of great exhibitions, the chemical industry is to be represented in all its branches. Hitherto, manufacturers have not taken sufficient interest in such displays; in the main, for two reasons. Firstly, the reputation of British heavy chemicals was, presumably, too well established to warrant representation; and, secondly, fine chemicals and dyestuffs were too undeveloped to admit of the manufacturers thereof indulging in such heavy expenditure.

Quoting from the *Empire Exhibition News* (February, 1923), about 50 firms have been entered. Home alkalis and the complete range of coal by-products will be exhibited, as well as fine chemicals and domestic materials. A most interesting feature will be the presence of the leading scientific societies for the purpose of illustrating the progress of pure and applied chemistry during the past 10 years; this will cover the period of the late war.

As the European upheaval depressed the industry, so will the Exhibition more than revive it. Dyestuffs, certainly, will benefit; while the general lines of future research will be more in co-ordination with industrial requirements.

Organisation of the Chemical Section is being undertaken by the Association of British Chemical Manufacturers, and it is to be hoped that firms will do their utmost to arrange for exhibits—to the benefit of all concerned. J. M.

THE PROBLEM OF SUBSTITUTION IN THE BENZENE NUCLEUS AND THE THOMSON-LEWIS-LANGMUIR THEORY OF CO-VALENCE.

By Ronald Fraser and James Ernest Humphries.

(*Continued from Page* 245.)

The electromer present in greater concentration—a factor evidently determined by the relative *octet stabilities* of X_1 and X_2—will react with greater velocity with the entering group; and the resulting *trisubstituted compound will predominate in* the final products. If X_1 has the greater octet stability, further substitution will take place at the 4 and 6 positions; if X_2, at the 3 and 5 positions; *i.e.*, considered from the standpoint of X_1 alone, ortho-para if X_1 is negative and meta if X_1 is positive. *If the octet stabilities of* X_1 *and* X_2 are widely different, one electromer may be present in such small concentration that its resultant will not be capable of detection in the final products. On the other hand, if the octet stabilities of X_1 and X_2 are of the same order, the number of products will be greater. The two possibilities may be illustrated by the iodination of o-toluidine (Wheeler and Liddle, *Amer. Chem. J.*, 1909, XLII., 501), and the nitration of o-chlortoluene (Wibaut, *Rec. Trav. Chim.*, 1913, XXXII., 244).

Similar reasoning applies to disubstituted derivatives of the type C_6H_4 $X_1(_1)$ $X_1(_4)$

Case 2, Fig. 3, ii. In this case the octet tendencies of X_1 and X_2 reinforce each other, and a single electromer exists. Substitution would be expected to occur at the 4 and 6 positions, which is in agreement with the facts.

Case 3. This is similar to Case 1. If the octet instability of Y_1 is greater than that of Y_2, electromer (a) will predominate, and if conversely, electromer (b). Further substitution will proceed accordingly.

The type C_6H_4 $Y_1(_1)$ $Y_2(_4)$ is similar.

Case 4. A single electromer. Further substitution at 5.

Case 5. A single electromer. The groups X and Y reinforce each other's natural octet tendency. The smooth nitration of the nitrophenols is all in agreement with this statement. The type C_6H_5 $X(_1)$ $Y(_4)$ falls under this case.

Case 6. Equilibrium between electromers holds in this case; reference to Postulate 2 indicates that, the direction of equilibrium will be that shown (Fig. 3, vi.), and hence ortho-para directive substituents will exert the greater influence in orientation.

The Effect of Conditions.

One of the main difficulties to the formulation of definite rules summarising the facts of orientation is the effect of conditions in altering the relative amounts of the final products of a reaction. On the octet view, this means that the equilibrium

pictured above in the electromeric equations, or, in the cases where a single electromer exists, the relative octet stabilities of the substituents, is altered. In either instance, this would indicate that the effect of conditions is largely one of electron transference.

The work of Biltz (*Z. Elek.*, 1911, XVII., 676) has shown that carbon possesses a very *high characteristic vibration frequency*; and, as stated by W. C. McC. Lewis (*System of Physical Chemistry*, vol. III., 62), " an atom possessing high frequency is no doubt the most likely type of atom to allow of the transference of electrons to and from itself." That electron energy increases with rise of temperature has been indicated by Koenigsberger (*Z. Elek.*, 1911. XVII., 289), and electron lability must also be affected by the nature of the solvent medium (dielectric constant, etc.). It is along these lines that we hope to approach the problem of conditions.

REPLACEMENTS AND OCTET STABILITY.

The term "Replacement" is used to denote the exchange of one substituent for another; "Substitution" refers to the exchange of hydrogen for an entering group. It seems to us that no essential distinction can be drawn between the two processes; and we regard substitution merely as a special case of replacement. No rule of replacement corresponding to a rule of substitution has, so far as we can find, been formulated; but consideration of our remarks on the special case of the " octet stability " of hydrogen appears to lead to some degree of uniformity in this respect. It was pointed out that the lability of hydrogen was conditioned by its tendency to give up its electrons; whereas octet completion is the determining factor in the lability of all other elements attached to the nucleus. In other words, a labile hydrogen is attached to a negative carbon atom, while a labile radicle other than hydrogen is attached to a positive carbon.

Thus, any rule which expresses the facts of substitution will be reversed in the case of replacement; by "reversed" we mean that a group which causes *substitution* in the meta position will favour *replacement in the ortho-para positions, and conversely*.

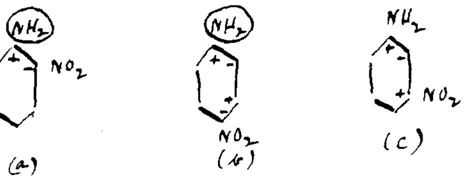


Fig. 4.*

For example, the nitro group causes substitution in the meta position; but in the hydrolysis of the nitranilines, replacement of NH_2 by OH occurs at the ortho-para positions to the nitro group, and not at the meta position. Reasoning on the same lines as those employed in the discussion of substitution, it will be seen (Fig. 4, a and b), that the octet stability of NH_2 is reinforced by the polarity effects of the nitro group: whereas in Fig. 4 (c), the polar tendencies of NH_2 and NO_2 are opposed, and the lability of NH_2 consequently diminished.† We have found the above rule (which is, of course, the obverse of the Brown and Gib-

* *A ringed group, thus* (x), *is used here to denote lability following on octet stability.*

† *Reference to Case VI. shows that m-nitraniline exists as two electromers, the* NH_2 *group exerting the greater directive influence. It would appear that the lability of a group is more easily influenced by one of opposite polar tendency than is its directive influence; and this is in general agreement with our views on reactivity. In this connection it should be noted that the* NH_2 *group in aniline itself, while exerting full directive power, requires the reinforcement of ortho or para nitro groups to render it labile in hydrolysis; and many other similar instances could be cited.*

son rule) to be of general application to the simpler cases.

Another interesting rule follows from the unique electrical character of the carbon atom discussed above, if we enquire how the tendency there mentioned towards increasing differentiation of polarity in a chain of carbon atoms can be satisfied.§ The inductive effect of a substituent on the carbon atoms of the nucleus is greater the greater its octet stability (*cf.* discussion of the Holleman Series); hence the differentiation of polarity of the carbon atoms will be increased by the replacement of the given substituent by a group of greater octet stability. The rule may therefore be stated thus; in replacements, *the entering group is one of greater octet stability than the group replaced.* The hydrolysis of the nitranilines is a case in point, and many others have been examined, and the rule found to hold.*

A striking example of the application of the rule is seen in the work of Swarts (*Bull. Acad. roy. Belg.*, 1920, 389) on the nature of the CF_3 group. CF_3 is, as one would expect, meta directive. Unlike $C_6H_5CCl_3$, $C_6H_5CF_3$ can be nitrated under ordinary conditions without hydrolysis of the CF_3 group. This is precisely what we should expect on the octet view. It was pointed out (see last week's issue) that fluorine was in all probability more octet stable than any other atom or group; therefore, while the replacement of Cl by the more octet stable OH group is to be looked for, replacement of F by OH is, according to the rule, difficult or impossible.

Hitherto the application of the rule has been confined to the entry of groups of an essentially electronegative character; but we have found that the important class of reduction reactions, where a group is replaced by hydrogen, falls equally under the rule. In a recent series of papers, Macbeth and his co-workers (Henderson and Macbeth, *T.*, 1922, CXXI., 892; Hirst and Macbeth, *ibid.*, p. 904; Macbeth, *ibid.*, p. 1116) have pointed out that, different as are the structures of compounds with halogens labile towards reducing agents, they have in common the possession of halogen with a strong induced positive polarity—that is, on our view, octet unstable. The octet instability in the cases cited by these authors appears to be unusually pronounced, and hence their ready replacement by negative (octet stable) groups is not to be expected. Their replacement by hydrogen, however, which tends to become electropositive and "octet stable" at the same time (*vide supra*), is in agreement with the rule and with its underlying foundation, viz., *the tendency towards increasing differentiation of polarity of the carbon atoms.* The replacement of the halogen by metals in this class of compound (Henderson and Macbeth, *loc. cit.* p. 895) is a similar example of the rule.*

It is important to note here the finding of Burton and Kenner (*T.*, 1922, CXXI., 675), that in the removal of halogen in the reduction of halogenated nitro-compounds, the reduction of the nitro groups to amino groups in all probability precedes the removal of the halogen (*cf.* the examples cited by Burton and Kenner, *loc. cit.*, and the papers of Macbeth and his co-workers mentioned above). The present theory would predict that such is the course of these reactions.

EFFECT OF GROUPS ON EACH OTHERS REACTIVITY.

We can now refer more particularly to the loosening or tightening effects on substituents caused by other groups present in the nucleus, as has been referred to already

§ *The rules of Michael and Markownikoff may be a consequence of this property of a chain of carbon atoms, the inductive effects being more pronounced when the chain is unsaturated (Kermack and Robinson, loc. cit., pp. 430-432). In the examples* $CH_2:CH \cdot COOH + HBr = BrCH_2.CH_2.COOH$; *and* $CH_3.CBr:CH_2 + HBr = CH_3.CBr_2.CH_3$, *the reaction has taken place which increases the polarity (positive or negative) of the carbon atoms.*

* *An apparent exception to the rule is the action of* PCl_5 *on phenols, where OH is replaced by Cl. The chlorines in* PCl_5, *however, may be in an exceptional state of octet stability (cf. Thomson, Phil. Mag., 1921, [vi.], XLI., 521). It is in agreement with the deductions above that the reaction takes place more readily with p-nitrophenol than with phenol itself.*

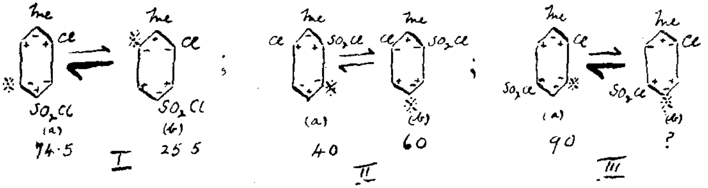
* *The activity or inertness of halogen in the compounds cited by Kenner (T., 1914, CV., 2719) and explained by him on Flürscheim's formulation, can be equally well interpreted, along the above lines, on our views.*

in the simpler cases (Fig. 4). Among the numerous examples examined, may be cited the following: the loosening effect of meta directive groups on substituents in the ortho-para positions (Schopf and his collaborators, *Ber.*, 1889, XXII., 900, *et seq.*; Kenner, *loc. cit.*); the loosening of ortho-para directive groups on substituents in the meta position (Kenner and Parkin, *T.*, *1920, CXXVII., 855; Holleman and* Hollander, *Rec. trav. chim.*, 1920, XXXIX., 435; Guia, *Gazzetta*, 1921, LI., i., 307; Burton and Kenner, *T.*, 1922, CXXI., 489); the tightening effect of ortho-para directive groups on bromine in the para position (Meyer, *Ber.*, 1921, LIV., [B], 2265). An examination of these will show that our views, and in particular Postulate 3, are capable of predicting the observed facts.

The Directing Group in Polysubstituted Compounds.

In a large number of cases examined by Robinson (Perkin and Robinson, *T.*, 1914, CV., 2379; Jones and Robinson, *T.*, 1917, CXI., 906; Gibson, Simonsen, and Rau, *T.*, 1917, CXI., 73), it is found that when a negative group is in the ortho-para position to a positive group, they neutralise each other, and the orientating effect is exercised by the second positive group. The work of Davies on the cumulative effect of *the chlorine atom and the methyl and sulphonyl* chloride groups on substitution (Davies, *T.*, 1921, CXIX., 853-876; *ibid.*, 1922, CXXI., 785) affords interesting examples of the applicability and otherwise of the Robinson rule.

In attempting to determine the position taken up by a fourth substituent in a trisubstituted derivative, two main considerations are of importance, viz., the relative octet stabilities of substituents already present, and the persistence of their inductive effects through a chain of carbon atoms.



Percentage yield of corresponding nitro compounds (substitution at asterisk).

Fig. 5.

The substances on which Davies worked (Fig. 5) contain in each case CH_3 and Cl in the ortho relation, the SO_2Cl occupying various positions relative to them. The octet stability of Cl being greater than that of CH_3, *the predominating polar state of* the molecule, in the absence of the SO_2Cl group would be as indicated in Fig. 5, ia, iia, iiia. Consider now the question of the persistence of induction. In Fig. 5 i., the inductive tendency of Cl in reversing the natural polarity of SO_2Cl is greater than that of CH_3, which has the opposite tendency, owing to the difference in the number of carbon atoms through which induction has to be effected. On the other hand, in Fig. 5 ii., the greater inductive power of Cl as compared with CH_3 is balanced by the weakening effect of the carbon atoms intervening between Cl and SO_2Cl.* In Fig. 5 iii., the SO_2Cl and Cl have the same polar effects on the nuclear atoms. The

* *Morgan and Jones* (*T.*, 1921, CXIX., 187) *on nitrating* 2-*chloro* 6-*nitrotoluene, obtained* 90 *per cent. of the compound corresponding to* iia *above, and* 5-10 *per cent. of* iib. *Reference to remarks on the order of the meta directive substituents indicates that electromer* (a) *can exist in greater concentration when an* NO_2 *group is in place of* SO_2Cl.

electromeric equilibria in the three cases will therefore be as shown in that figure, and the yields of the nitration products are in agreement. Thus it will be seen that the present theory is borne out by the above experiments; whereas the Robinson rule fails in the third example (*v.*, Davies, *T.*, 1922, CXXI., 786; but compare footnote to same page).

The results of Gibson, Simonsen, and Rau (*T.*, 1917, CXI., 69) on the nitration of 2-acetylamino-3-4-dimethoxybenzoic acid and of 3-acetylamino-veratrole, and of Simonsen and Rau (*T.*, 1917 CXI., 220) on the nitration of isomeric acetylamino methoxybenzoic acids, are difficult of interpretation on the octet view, partly owing to the large number of substituents, and hence the difficulty of determining their mutual interdependence; and partly to the difficulty at the present stage of dogmatising with regard to the relative octet stabilities of NHAc and OMe.

In the above, we have attempted, on the basis of the Thomson-Lewis-Langmuir theory of co-valence, to connect various theories and rules which at first sight may seem wide apart; to give as consistent a basis as we could to certain observed regularities; and further, to formulate generalisations which may be of use in classifying, and perhaps in predicting the course of, substitution reactions.

SUPPLEMENTARY NOTE.

It should be observed that our view of the mechanism of induction differs somewhat from that of Kermack and Robinson (*loc. cit.*), inasmuch as actual "appropriation" of electrons by octet stable centres is postulated by us. That this is not the opinion of Kermack and Robinson was made clear by Professor Robinson at the Hull meeting of the British Association, 1922. It is our intention to attempt to obtain experimental evidence, which will give at least a pointer as to the correctness or otherwise of our ideas on this point.

Chemistry Department,
University of Aberdeen.

A NEW TEST FOR NITRATES.

BY IVOR G. NIXON.

The "Ring Test" for nitrates possesses two main disadvantages, namely, the ferrous sulphate solution does not keep well, whilst if made up freshly each time, the salt dissolves but slowly in the cold water. It appeared possible to the writer that some of the nitro-sulphonic acids of the naphthalene series, which are noted for their intense and persistent yellow or red colour in solution, might be utilised to provide a sensitive test for nitrates which would be free from these disadvantages. These nitro acids are easily formed by adding nitric acid to a solution of the sulphonic acid in concentrated sulphuric acid, hence it would appear possible that the addition of a few drops of a water solution of one of these sulphonic acids to a mixture of the suspected nitrate, in water solution, with an excess of concentrated sulphuric acid, should cause a distinctive colour to be developed if a nitrate is present. This test was tried, using *β*-naphthalene sulphonic acid, but negative results were obtained. "G Salt" (2:6:8 naphthol disulphonic acid), "Gamma acid" (2:6:8 aminonaphthol sulphonic acid), "Schaffer's acid" (2:6 naphthol sulphonic acid), and the "Cleve's" acids (1:6 and 1:7 naphthylamine sulphonic acids), however, were all found to react vigorously, giving wine red solutions. The test is very sensitive, with "G Salt," for instance a distinct red colour is given by 0.02 milligrams of nitrogen as nitric acid, whilst with much smaller quantities a faint yellow colour is still obtained. Under these conditions, the "Ring Test" gives negative results. There is no need to cool the solutions during the test, as must be done during the ring test. Indeed, it was found that the application of moderate heat often deepens the colour—thus if the test mixture in which "G Salt" has been used is boiled, the colour becomes more intense, and rather bluer in tone. Under the same conditions for "Gamma acid," the wine red colour of the solution becomes an olive-green. Nitrites also answer to the test. The general method of procedure is as follows:—

About one cubic centimetre of the suspected solution is mixed with approximately an equal volume of concentrated sulphuric acid, and then about five cubic centimetres of a 1 per cent. solution of "G Salt" slowly added, if a nitrate or nitrite is present an intense wine red colour is developed. The test may also be applied as a ring test, in this case, the nitrate solution is mixed with that of the sulphonic acid, and concentrated sulphuric acid then run

down the side of the test tube. A red ring is formed at the junction of the two liquids, and on shaking the tube, this colour is communicated to the whole of its contents.

AN EXPLANATION OF THE THEORY OF THE ROTATION OF THE ATOMIC NUCLEUS.

By Herbert Henstock,

PART 1.

In a previous communication (*The Chemical News*, 1923, CXXVI., 129) the author gave a general description of the manner, in which the atomic nucleus plays its part in the union of atoms, together with certain effects and consequences which must follow such action. It is now proposed to describe this action a little more in detail, and to attempt to show its bearing upon some of the difficulties met with both in inorganic and organic chemistry: but before showing its applications to concrete cases, it has been thought better to give a general explanation here, and to defer particularisations to the future parts of this series.

This hypothesis in no sense pretends to supersede or to invalidate the theory of the Induced Alternate Polarity of Atoms, but is put forward as an explanation of the underlying cause of that theory, or, to be more exact, that law; for alternate polarity has now got beyond the stage of theory and is beginning to be recognised as an actuality. In explanations of alternate polarity, as, for example, that given by Kermack and Robinson (*Trans. Chem. Soc.*, 1922, CXXI., 427), the idea that a negative atom appropriates to itself some of the electrons of neighbouring atoms, and that a positive atom tends to disintegrate, may or may not be true; but the author's point is that all such features are merely manifestations or results of alternate polarity and not the cause of it, the cause is the nucleus of an atom.

If this hypothesis be applied to the Lewis-Langmuir conception of the atom, then the general effect of the nucleus upon the octet will be seen from Fig. 1.

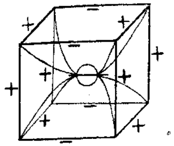


Fig I.

Part of the number of edges, where single valence bonds may exist, will be positive and part negative in the same atom, so that when two atoms of the same element unite to for ma molecule they both have similar potentialities for molecule formation. If we imagine such an atom travelling with one of its negative edges in front, when it meets another atom similarly situated moving to meet it, the second atom will probably rotate as a whole until one of its positive edges faces the first atom, when union will occur: this will be especially the case in those elements strong in "permanent polarity" (*The Chemical News*, loc. cit.), but it is more than probable that this will occur between all atoms of the same element. The case may be somewhat different, however, between two or more atoms of different elements: an atom, strong in permanent polarity, may actually rotate the the nucleus of another much weaker one; as an example, a chlorine atom may rotate the nucleus of a carbon atom, but would not rotate that of a sodium atom, the sodium atom would rotate as a whole till a positive edge faced the chlorine, just as would be the case with two chlorine or two sodium atoms. This effect may be seen from Fig. 2.

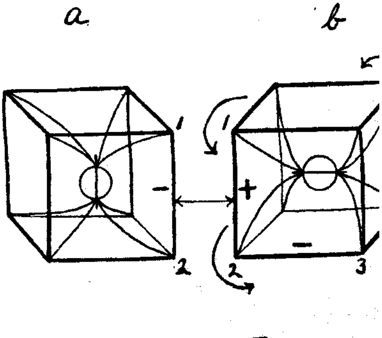


Fig. II.

If A and B be two chlorine atoms, and A is travelling towards B with its edge 1-2 in front, and B is moving towards A with its edge 2-3 in front, then the whole of atom B will revolve till its edge 1-2 faces A. If A be a chlorine and B a sodium atom the same thing will happen, but if A were a chlorine and B a carbon atom, then the union might be made between A 1-2 and B 2-3, but the nucleus of B would revolve through an angle of 90°, making the edge 2-3 a positive one, especially if the carbon atom were already combined with other atoms.

In working out the various problems, the following rules have been found to hold good:—

(1) The normal primary valencies in any atom will be wholly confined to negative or wholly to positive edges.

(2) When an atom unites normally by its negative edges and any compound is formed where a positive edge comes into play, then that compound will be an unstable one. The converse for normal positive edges also holds.

(3) The nearer together the nuclei come in a molecule, the more unstable it will be.

(4) Electrons are more strongly held to the nucleus along a negative edge than along a positive one.

(5) When electrons are moved from one corner to another in the octet, a strain is caused in the atom.

(6) Two electrons at one corner in a bond are a source of weakness in the bond.

(7) Distortion of the octet is always a source of weakness in the molecule.

A chain of atoms will be represented as in Fig. 3.

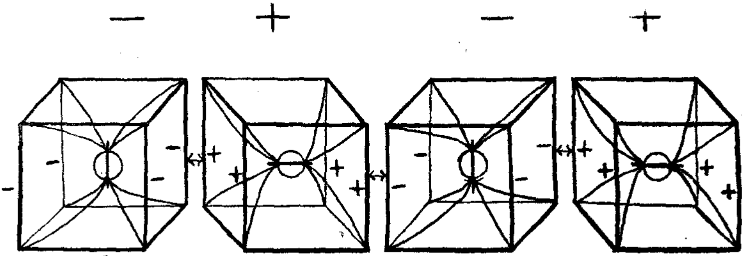


Fig III

The normal unsatisfied valence bonds will lie in the vertical direction in each atom in accordance with rule (1), and any union along a horizontal bond will be unstable, as follows from rule (2).

Lapworth's law of alternate polarities is here clearly demonstrated.

A double bond is shown in Fig. 4.

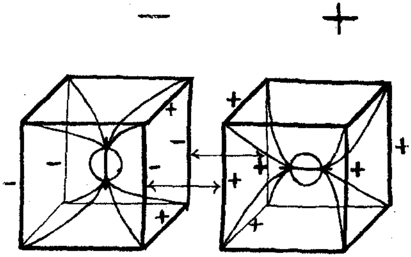


Fig. IV

The two cube faces both come together, so that four edges touch in each atom, which constitutes one of the weaknesses of the double bond, since in the case of the the negative atom rules (1) and (2) both operate. Also the nuclei are nearer to-

gether than they are when united by a single bond, hence rule (3) operates, which is a second cause of weakness.

A treble bond may be seen in Fig. 5 representing two carbon atoms.

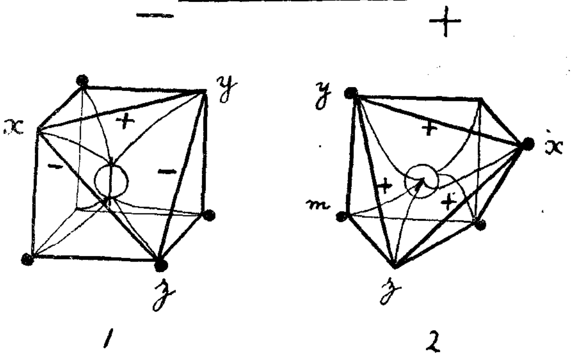


Fig V

In the negative atom the nuclear poles are parallel with the plane of x y z, but in the positive one they are at right angles to the plane of x y z.

If the distorted cube representing the positive atom could be taken up, turned over and applied to the negative one, so that x, y and z in each would coincide, then the bond would be complete.

In the negative atom, the electron, from the corner of the octet which has vanished, has been driven down to z, and in the positive atom the electron from z has been driven to m.

There are at least three sources of weakness in this bond:

(1) The octet is distorted and electrons *driven from the corners which have disappeared* to any of the corners x, y and z. See rules 5 and 7.

(2) In the two triangles, x y z

1 xz is −
2 xz is +
1 yz is −
2 yz is +
1 xy is +
2 xy is +

In the negative atom, negative and positive bonds come into operation, also two positive bonds come together. See rules 1 and 2.

(3) The two nuclei are still closer together than in a double bond. See rule 3.

A treble bond is therefore a very weak one when acted upon by other atoms, *i.e.*, when acted upon by the electricity of other *atoms, but it is often very stable to heat*, as for instance in the case of acetylene. The action of electricity and of heat upon a bond *are therefore often quite different* and not comparable; heat may or may not (and more often does not) rotate the nucleus of *an atom in the same way that the* electricity of another atom will do. These two forces are often confused when comparing *the relative stability of compounds*; a substance easily decomposed by heat is often broken up by different causes and often in different ways from those due to either a current of electricity or the electricity of an atom: as an example might be mentioned the deposition of copper from a solution of cupric nitrate by a current of electricity or by metallic iron, whereas heat leaves cupric oxide instead of the metal. Therefore, unless otherwise specified, a weak bond may be taken to mean that which is weak in an electric sense between atom and atom.

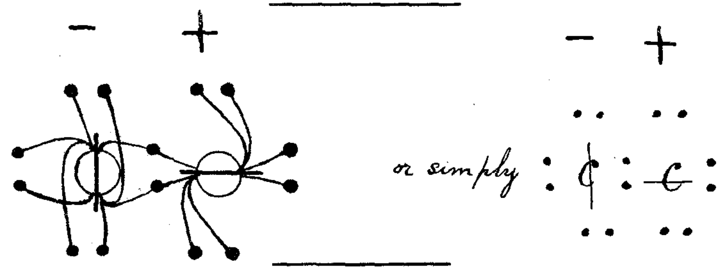
Distortion of the octet must occur in a double bond, and there seems no reason why it should not do so in all atoms where there are three or four vacant corners to the cube; in fact, some kind of distortion might occur in any uncombined atom, with the exception of those of the inert gases. It is inconceivable to imagine that the element carbon alone has the form of what might be termed a distorted cube. In the case of carbon this distortion may occur not only to the extent of the complete tetrahedron but, as will be shown later, partial distortion of the cube, between it and the tetrahedron may occur when carbon is in the combined state. This idea may be extended to the octets of the other elements, and in conjunction with the direction of the tubes of force emanating from the nucleus it will be found capable of explaining many anomalous cases of valence, together with weakness in bonds with consequent instability of molecules.

The usual notation suffices to show the arrangement of electrons and bonds, if it be remembered that all the ordinary unions are made normally

I.—By single bonds:

(*a*) In negative atoms by electrons which are joined to opposite ends of the nucleus.

(*b*) In positive atoms by electrons which are joined to the same end of the nucleus.

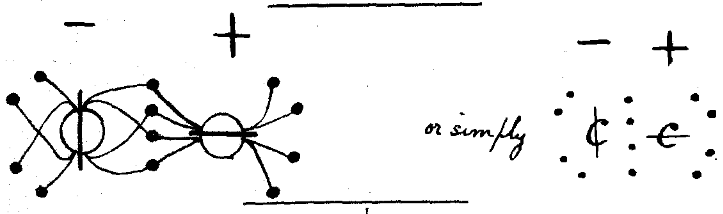


In each of the pairs, the electrons are to be imagined to be one above the other in planes at right angles to the plane of the paper, and *not* in the plane of the paper: this also applies to double and treble bonds.

II.—By double bonds:

(*a*) In negative atoms the four electrons of the double bond are alternately joined to either end of the nucleus and in the remaining two unions the electrons of each pair are joined to opposite ends of the nucleus.

(*b*) In positive atoms double bond electron pairs are joined to one end of the nucleus, the other two valence pairs to the opposite end.

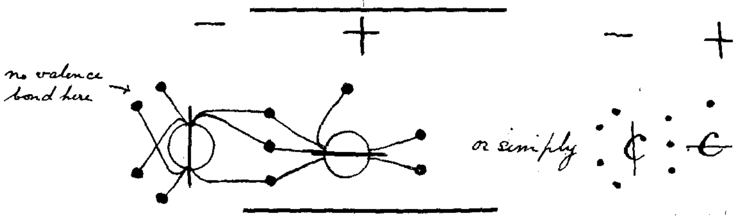


III.—By treble bonds:

(*a*) In negative atoms the three electrons, forming the bond, are joined two to one end of the nucleus and one to the other; the two electrons forming the single bond are each joined to opposite ends.

(*b*) In positive atoms all three electrons

of the treble bond are joined to one end of the nucleus, and the two single bond electrons to the other end.



Here it cannot be seen that the positive carbon atom shares two of its electrons with the negative, which latter shares but one with the positive, without reference to Fig. 5. In the negative atom there is only one "single bond," although there are four electrons, and in the positive atom there is a single electron which is apparently alone, but the true significance is not seen without drawing the octets and putting in the lines of force, when the matter at once becomes clear, which is a good demonstration of the importance of the lines of force in any cases of doubt as to how a substance is constituted.

Chemical Research Laboratory,
School Gardens,
Shrewsbury.

GENERAL NOTES.

GERMANY'S TRADE INDUSTRY DURING MARCH.

The Commercial Secretary at Berlin (Mr. J. W. F. Thelwall) has forwarded to the Department of Overseas Trade a survey of the position of trade and industry during March.

It appears that un-occupied Germany has borne the cutting off of her most important industrial area comparatively well. The anticipated shortage of coal has not set in. The demand for pig iron and steel was also met. This was possible owing to the existing stocks, and increased imports, especially of English coal.

In the textile and tobacco industries there were further indications of a retrograde movement, while employment in the remaining industries was generally satisfactory in spite of high costs of production in consequence of the use of English coal. In occupied territory, however, works were compelled to incur heavy unproductive expenditure, and their free development was greatly interrupted by the blockade and other acts of intervention by the occupying Powers. They were forced to continue to work for stock.

Mining.

No definite information with regard to the coal output of the Rhenish-Westphalian coal district can be given. In the Central German brown coal district a not inconsiderable increase of output occurred. There was, however, an interruption of sales owing to a smaller demand on the part of the sugar working-up industry and also of the potash industry. The demand for Upper Silesian coal also partly ceased. It thus appeared that buyers had quickly covered their requirements as a result of the Ruhr occupation, and, with the uncertain economic situation and the expected reduction of coal prices, were not yet ready for new purchases. The gasworks belonging to communities particularly showed reserve in placing new orders.

Potash Industry.

The market conditions were unfavourable. In particular German agriculture, whose demand in this month is usually great, limited its purchases. The reason for this lay partly in the high prices of potash and coal, and also high freights, and partly because German farmers covered their requirements sufficiently in previous months at cheaper potash prices and freights. Foreign trade was confined with-

in comparatively narrow limits: only for sulphate of potash salts was the demand satisfactory. The market for the by-products of the potash industry also left much to be desired.

The *aluminium industry* continued to suffer, and the outlook for the near future is bad.

The *electro-technical industry* also suffered from lack of orders. An ample demand for electrical plant of all kinds existed, but there was nowhere any possibility of raising the requisite capital.

In general, employment in the electro-technical industry is assured for months ahead.

Chemical Industry.

Owing to the fact that prices in the chemical industry had reached and partly exceeded the world's market level, foreign orders declined. Competition with foreign countries was rendered particularly difficult by high railway freights, postal fees, and coal prices. In expectation of a reduction of prices, inland customers covered only their immediate needs in small quantities. There was still in stock a heavy proportion of goods purchased at high prices in January and February which could be disposed of only at a loss. Business in chemically pure reagents and preparations was almost completely at a standstill, owing partly to the closing of all institutes and universities for Easter.

Indiarubber Industry.

The position was unsatisfactory. The shortage of German coal necessitated increased purchases of English fuel. Conditions on the inland market were thoroughly unfavourable.

Glass Industry.

In the sheet glass industry the supply of raw materials was, in general satisfactory. The costs of manufacture approached the world's market prices. The inland demand continued to fall off. Belgian and Czech glass industries greatly injured the German industry on foreign markets, so that only very few sales to the eastern Border States were possible. Exports to Italy, Africa, and America were small. In the hollow glass industry a stagnation of sales set in, resulting in restrictions of work."

Fertilisers.

The market for nitrogenous fertilisers was stagnant. Some factories in occupied territory had to cease work. Prices were such that German nitrogen was still cheaper than foreign nitrogen.

In order to afford farmers who have not yet placed their spring orders, the possibility of purchasing nitrogenous fertilisers cheaply, the Nitrogen Syndicate has decided to sell such fertilisers for the time being at reduced prices, quite out of proportion to the reduction in coal prices of the 1st April. The lowered prices came into effect on the 3rd April.

SCIENTIFIC APPARATUS FOR BRITISH COLUMBIA.

H.M. Trade Commissioner in Vancouver, British Columbia (Mr. L. B. Beale) reports that the authorities of the University of British Columbia are desirous of receiving from U.K. manufacturers illustrated catalogues, full particulars, and prices of scientific apparatus.

Further particulars, together with the names of the enquirers, may be obtained by firms interested upon application.

The Commercial Secretary at Bucarest reports that the Roumanian Railroad Administration invites tenders for the supply of sulphate of copper.

Application for particulars should be made to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

THE DYE INDUSTRY.

NEW CAREERS CREATED BY AN ACT OF PARLIAMENT.

The effect upon the career of University men of new conditions in the Dyestuffs Industry is discussed in an interview by Professor Arthur G. Perkin, F.R.S., the head of the Departments of Colour Chemistry and Dyeing at Leeds University, where the summer term has just opened.

"Although the number of students entering our Colour Chemistry and Dyeing Department is falling, he said, "it still remains much higher than at any time before the war. A decrease to some extent is inevitable because, in the first place, many ex-army men have now finished their training, and, at the same time, fees have of necessity been considerably increased. This, I am afraid, may prevent many young men from taking our course.

"In the future we may have a normal sixty students taking our three years'

course either for the Diploma or Ordinary B.Sc. in dyeing, or our four years' course leading to the Honours B.Sc. in colour chemistry. In this case some twenty students will enter the dyeing, colour chemistry and allied industries each year. Much, however, depends upon Government action; for, if they repeal the Dyestuffs Act, there is no doubt that the artificial dyes industry will become moribund in this country. As it is, the forty-seven students who left me this year have all obtained positions not only in colour works, but in wool dyeing, cotton dyeing, calico printing, artificial silk, and other industries."

THE MINERAL OUTPUT OF YUKON.

Figures are to hand, authenticated by the District Gold Commissioner, Mr. George P. MacKenzie, showing the output of gold, silver, lead, and copper from this territory. The dominant note in his report is one of sheer optimism that the future holds much good, in the productive sense.

Conservative quotations show the total output as follows: Gold, $200,000,000; silver, 3,500,000 ozs., valued at $2,100,000; lead, 3,500 tons, valued at $400,000; copper, 12,000,000 pounds, valued at $2,700,000. Two million ounces of the silver was produced as a by-product in refining placer-gold; and the Mayo district, so long unworkable owing to difficulties of transport, has so far developed that 1,500 claims are now staked.

It has long been feared in the circles concerned that the mines were becoming used up, and that very little metal remains. Mr. MacKenzie refutes this belief, and terminates an interesting report with the following paragraph:—

"The views of the residents of the territory and all those interested in its mineral resources and production are now most optimistic. The life of the placer fields is anything but over, and now it appears certain that a period during which the silver-lead areas of the territory will equal or exceed the gold fields in the production of wealth has just been entered upon, while further gold, silver, and copper deposits may be said to be held in reserve awaiting the day when the world market calls them."

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, APRIL 26.

Papers read:—

T. R. MERTON, F.R.S., and R. C. JOHNSON: *On Spectra associated with Carbon.*

R. A. WATSON WATT and E. V. APPLETON, D.Sc.: *On the Nature of Atmospherics.* Communicated by Sir Henry Jackson, F.R.S.

W. A. BONE, F.R.S., D. M. NEWITT, and D. T. A. TOWNEND: *Gaseous Combustion at High Pressures. Part III.: The Energy absorbing Function and Activation of Nitrogen in the Combustion of Carbon Monoxide.*

I. MASSON, D.Sc., and L. G. F. DOLLEY: *The Pressures of Gaseous Mixtures.* Communicated by Professor F. G. Donnan, F.R.S.

Papers read in title only:—

W. R. BOUSFIELD, F.R.S., and C. ELSPETH BOUSFIELD: *Vapour Pressure and Density of Sodium Chloride Solutions.*

F. A. LINDEMANN, F.R.S., and G. M. B. DOBSON: *A Note on the Temperature of the Air at Great Heights.*

G. H. HARDY, F.R.S., and J. E. LITTLEWOOD, F.R.S.: *On Lindelof's Hypothesis concerning the Riemann Zeta-function.*

ROYAL INSTITUTION.

On Thursday, April 26, Professor J. T. MACGREGOR-MORRIS began a course of three lectures at the Royal Institution on *Modern Electric Lamps.* On Saturday, April 28, Dr. LEONARD WILLIAMS will deliver the first of two lectures on the *Physical and Physiological Foundations of Character.*

The Friday evening discourse on April 27 will be delivered by Mr. C. V. BOYS, on *Measurement of the Heating Value of Gas,* and on May 4 by PROFESSOR SODDY, on the *Origins of the Conception of Isotopes.*

ROYAL SOCIETY OF ARTS.

On Friday, April 20, there was a joint meeting of the Dominions and Colonies and the Indian Sections. SIR RICHARD A. S.

REDMAYNE, K.C.B., M.Sc., M.INST.C.E., M.I.M.E., F.G.S., delivered a lecture entitled *A Review of the Base Metal Industry, with Special Reference to the Resources of the British Empire.* The Rt. Hon. Lord Emmott, G.C.M.G., G.B.E., presided.

On Monday, April 23, MR. E. KILBURN SCOTT, M.I.E.E., A.M.INST.C.E., gave his (third) Cantor lecture, *Nitrates from Air.*

On Wednesday, April 25, there was a conference on *The Milk Question* at the Ordinary Meeting. Short papers were read as follows: (1) *The Arguments for Maintaining an Open Market for Fresh Milk,* by PROFESSOR R. STENHOUSE WILLIAMS, M.B., B.Sc., L.R.C.P., and S.E., D.P.H.; *Changes in the Digestibility and Nutritive Value of Milk Induced by Heating,* by PROFESSOR J. CECIL DRUMMOND, D.Sc., F.I.C.; (3) *The Effect of Heat on Some Physiological Principles in Milk,* by S S. ZILVA, PH.D., D.Sc., F.I.C. A demonstration of some of the chemical changes in milk on heating to various temperatures was given by CAPTAIN JOHN GOLDING, D.S.O., F.I.C., and MRS. A. T. R. MATTICK, M.Sc. The Rt. Hon. F. D. Acland, M.P., presided.

ARRANGEMENTS FOR MEETINGS UNTIL THE END OF THE PRESENT SEASON.

Monday, April 30, 8 p.m. (Howard Lecture): *The Development of the Steam Turbine,* by STANLEY S. COOK (Lecture 1).

Wednesday, May 2, 8 p.m. (Ordinary Meeting): MAURICE DRAKE, *The Fourteenth Century Revolution in Glass Painting.* Professor W. R. Lethaby will preside.

Monday, May 7, 8 p.m. (Howard Lecture): *The Development of the Steam Turbine,* by STANLEY S. COOK (Lecture 2).

Wednesday, May 9, 8 p.m. (Ordinary Meeting): WILLIAM ARTHUR BONE, D.Sc., PH.D., F.R.S., Professor of Chemical Technology, Imperial College of Science and Technology, South Kensington, *Recent Developments in Surface Combustion.* D. Milne Watson M.A., LL.B., Governor of the Gas Light and Coke Company, will preside.

Monday, May 14, 8 p.m. (Howard Lecture): *The Development of the Steam Turbine,* by STANLEY S. COOK (Lecture 3).

Wednesday, May 30, 4.30 p.m. (Ordinary Meeting): A. J. SEWELL, *The History and Development of the Perambulator and Invalid Carriage.*

Friday, June 1, 4.30 p.m. (Indian Section): AUSTIN KENDALL, I.C.S. retd., *The Indian Section of the British Empire Exhibition,* 1924.

Friday, June 15, 4.30 p.m. (Indian Section): SIR JOHN H. MARSHALL, C.I.E., M.A., LITT.D., F.S.A., Director-General of Archæology in India, *The Influence of Race on Early Indian Art.* (Sir George Birdwood Memorial Lecture.)

ROYAL MICROSCOPICAL SOCIETY.

The section of the Society which has been formed to deal with the Industrial Applications of the Microscope, and to assist in the development of Industrial Research in British Industries, held a meeting on Wednesday, April 25.

Messrs. C. Baker exhibited their junior engineer metallurgical microscope and the Greenough binocular microscope.

Messrs. R. & J. Beck, Ltd., demonstrated a new research outfit for metallurgical work, including microscope, camera, optical bench, etc.

The Edison Swan Electric Co., Ltd., showed their projector and fullolite lamps.

Mr. Mansell P. Swift demonstrated the use of Dichroiscopes for the identification of certain gem stones.

Messrs. W. Watson & Sons exhibited petrological microscopes.

Mr. J. E. BARNARD, F.INST.P., F.R.M.S. gave the first of a series of short communications on *The Manipulation of the Microscope in Industrial Laboratories. Part I.: Illuminants and Illumination.*

DR. MARIE C. STOPES, D.Sc., PH.D., F.L.S., read a paper entitled *The Microscopical Examination of Coal in relation to Fuel Economy and Efficiency.*

Future meetings will be held as follows:

May 16: MR. LEONARD TAVERNER, A.R.S.M., *The Principles and Application of Technical Metallurgical Microscopy.*

MR. W. M. AMES, M.A., B.Sc., A.I.C., *Applications of the Microscope in the Manufacture of Rubber.*

May 30: MR. JOSEPH M. COON, *On the Microscopical Determination of Cassiterite in Rock Sections.*

MR. H. B. MILNER, *The Microscopical Investigation of Sands for various Industrial Purposes.*

The Industrial Applications Section of the Royal Microscopical Society has been formed for the purpose of assisting in the

development of Industrial Research in British Indutries, and holds regular monthly meetings with practical demonstrations connected with the reading and discussion of communications dealing with Industrial Research problems.

Enquiries and suggestions are solicited by the Honorary Secretaries to the Section: W. E. Watson Baker, A.Inst.P., 313, High Holborn, W.C.1, C. F. Hill, M.Inst.M.M., A.Inst.P., Moore, Warrington.

THE CHEMICAL SOCIETY OF JAPAN.

The following papers have been communicated to the Society:—

Studies on Accelerators of Oxidation. Part I. Action of Ferric Sulphate upon Potassium Permanganate, by BUNSUKE SUZUKI and CHUJIRZ HAMADA.

On the Oxidase-like Action of Complex Salts of Metals. Part III. Decomposition of Hydrogen Peroxide by Complex Salts of KANEKO.

Influence of Heating and Oxidation on the Vitamine A and B of Milk, by HIDESABURO SEKINE and TAMOTSU OKAMURA.

Studies of Metallic Oxides and their Hydrates by X-Rays. Part I. X-Ray Analysis of Stannic Oxide and its Hydrates, by NOBUO YAMADA.

Braun's Law and Thallous Sulphate, by FUSAO ISHIKAWA.

The Society of Motor Manufacturers and Traders, Ltd., have decided to organise, from Thursday, November 22, to Saturday, December 1, 1923, in the recently enlarged Olympia, an Exhibition embracing not only the various types of commercial motor vehicles and their components and accessories, but also plant, machinery and materials used in the construction, maintenance, and development of roads.

The exhibition will be divided into four sections: Commercial motor vehicles and body work; accessories and components; tyres; and road plant, machinery, and materials.

The exhibition manager will be pleased to supply copies of the conditions and forms of application for space, on application to the Society's offices, 83, Pall Mall, London, S.W.1.

CORRESPONDENCE.

ATOMIC THEORIES.

To the Editor of THE CHEMICAL NEWS.

SIR, — With regard to the notice of the second edition of my *Atomic Theories*, which you kindly gave in your last issue, the point raised by the reviewer concerning the positions of the electrons in the carbon atom is certainly an interesting one.

At the time of writing I did not regard the positions of the electrons as absolutely assigned and always definitely fixed to certain corners of the cube; for, even supposing the arrangement to be as shown by Fig. 19, on page 90, which is the one expected when the four electrons are free to take up positions of equilibrium in the outer shell of the atom. But in the case of the combination shown in Fig. 33 on page 90, it seems probable, as your reviewer has pointed out, that the electrons might take up changed positions to meet the vacant places in one of the oxygen atoms, if this latter happens to be in the position shown in the figure.

If, however, one of the oxygen atoms is orientated through an angle of 90 degrees, then, of course, this orientation of the carbon electrons would not take place. The electrons would have the positions as shown in the earlier figure.

Other considerations also tend to show that the electrons may alter their positions in the atoms.

I am, Yours, &c.,

F. H. LORING.

London, S.W.4.
April 21, 1923.

NOTICES OF BOOKS.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry, by J. W. MELLOR, D.Sc. Vol. III., pp. X. + 927. London: Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 1923. Price 63s. net.

This volume covers the elements Cu, Ag, Au, Ca, Sr, and Ba, and the mass of information it contains is enormous. Each element is dealt with from historical, geological, physiological and purely chemical aspects, and the various derivatives are enumerated separately. The last three substances are collected under the heading of alkaline earths.

There is no doubt that the work covers every by-way in the scientific knowledge of the elements, and the time and labour spent upon it cannot be described otherwise than as colossal; but the author has made the great mistake of adding a profusion of references. For instance, in the chapter upon cupric chloride and the complex salts thereof, there are no fewer than 4 pages of references, with 70 lines to the page.

Considerable attention has been paid to the sources of the elements (*i.e.*, the composition of the ores, etc), their extraction, and alloying. In fact, complete deduction from the crude ore to the most complex B.P. salt is one of the most prominent features. Qualitative and quantitative analyses have been associated with the most up-to-date methods of research, and various theoretical discussions are incorporated with great thoroughness.

Efficiency in authorship and editorship is evident in its maximum degree, and the work is most valuable for complete reference. So far it is incomplete, further volumes being in preparation, the next one dealing mainly with the radium and actinium families. We await its publication with interest, and, meanwhile, place the present volume high on the shelves of great works. J.M.

Elements of Glass-blowing, by H. P. WARAN, M.A., PH.D., F.INST.P. Pp. IX. + 116. London: G. Bell & Sons, Ltd., Portugal Street, W.C.2. 1923. Price 2s. 4d. net.

Manipulative skill in glass-blowing can only be acquired by patient practice—practice, it may be mentioned, along the correct lines.

Students show very unequal capacities in making progress in this direction, whilst much depends on their own ability, expert guidance counts for much. The examples of a clever manipulator greatly help them to become proficient.

The present manual on this subject will be found useful to students and inexperienced research workers called upon to carry out certain glass-blowing work, whether it be merely the joining of two tubes or the making of vacuum tubes or other elaborate apparatus. The principles and advice given by the author are sound, and the illustrations are very clear.

The book should certainly appeal to a wide circle of readers among chemists and physicists.

Atoms, by JEAN PERRIN. Authorised translation by D. LL. HAMMICK, M.A. Second English edition revised. Pp. XV. + 231. London: Constable & Co., Ltd., Orange Street, W.C.2. 123. Price 8s. 6d. net.

The second English translation of Prof. Perrin's *Les Atomes*, which has now been published, has been based upon the eleventh revised French edition.

The contents have been revised where necessary, in accordance with the rapid advances which continue to be made in atomic science.

A particularly lucid account of the experiments and views of Prof. Perrin and others on the Brownian movement, radiation, light and quanta, electrons, etc., are given, together with the advances in the study of the genesis and destruction of atoms by various investigators.

In the section entitled *Appendix*, 1921, there are notes on recent work in certain directions, *e.g.*, Corpuscular Swarms, Bohr's Theory, etc.

This English edition should serve, at least, to make Prof. Perrin's work more widely known, both here and in America.

Ink, by C. AINSWORTH MITCHELL, M.A., F.I.C. Pp. VIII. + 128. London: Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, W.C. 1923. Price 3s. net.

Whilst the author has not attempted to compile a laboratory or works manual, he has written a very readable and informative volume, which contains an account of the history and scientific developments of the manufacture and uses of inks.

Sufficient details are given of the processes for preparing the different kinds of ink for ordinary and special purposes, so that a clear and correct impression of the methods may be obtained.

After a description of the raw materials for making iron-gall inks, and their manufacture, there is a chapter on the methods of testing inks in general. In this and other chapters the author's special knowledge and experience is much in evidence. Besides the iron-gall preparations there are now numerous others, *e.g.*, logwood inks, vanadium inks, and those made from aniline black and similar dyestuffs. Special inks, such as those for copying, typewriting and printing, and Indian ink, all receive ade-

quate treatment, consistent with the size of the book.

The information contained in this little volume is noticeably free from industrial and scientific technicalities, thus making it available for general readers, as well as for chemists, analysts and others who may be specially interested in the subject.

The Recovery of Volatile Solvents, by C. S. Robinson. Pp. 188. New York: The Chemical Catalog Co., 19, East 24th Street. 1922. Price $2.50.

It is only of late that the recovery of volatile solvents has attained any importance in industrial chemistry. The subject has, however, been well investigated. The author of the present volume, who has himself made valuable contributions on the subject, is of opinion that future improvements in solvent recovery must be principally in the designing of suitable apparatus and in the improved application of known principles.

Prof. Robinson has presented a good and well illustrated account of these fundamental principles and their technical application. The book is divisble into six sections. The first six chapters give the important elementary principles. The technical readers of this volume may find the physical chemistry of this section hard reading, but it is of importance, since the chemical engineering involved rests upon these principles and laws.

The second portion of the book (chapters VII.-XI.) deals with the application of solid absorbents. The third part deals with the recovery of vapours by condensing and cooling processes. Part four (chapter XX.) covers the methods of combined cooling and compression. An account of the various methods of scrubbing constitutes part five, and a long and excellent abstract of the literature constitutes the final section.

This is the first book to deal exclusively with solvent recovery, and the author is to be congratulated upon the care which he has given to the compilation of this valuable contribution to technical literature.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

9004—Chemical Industry in Basle.—Manufacture of soluble acid in calcium salts of inosite-phosphoric acid. March 29.

8576—Laporte, Ltd., B.—Manufacture of barium peroxide. March 26.

8837—Casselle & Co., Ges.—Manufacture of alkylated derivatives of vat dyestuffs. March 28.

8992—Soc. l'Air Liquide, Soc. Anon. pour l'Etude et l'Exploitation Des Procedes G. Claude.—Manufacture of nitrogen peroxide. March 29.

8956—Verein fur Chemische und Metallurgische Produktion.—Production of chemically pure sulphuric acid. March 29.

Specifications Published this Week.

194740—Casale, Dr. L.—Process for the synthetic production of ammonia.

194779—Waldberg, A.—Electro-metallurgy or the electro-deposition of metals.

181677—Blanc, G. A.—Method of and apparatus for the treatment of silicates with acids in order to obtain solutions of salts free from silica.

188338—Kinzlberger & Co.—[illegible]aration of iron-free chromium comp[illegible]s.

Abstract Published [illegible] Week.

192941—Phenol-aldehyde cond[illegible]ation products.—Byron, J. G., 1, Norfolk Avenue, Heaton Chapelm, near Stockport; and Attwater, R., Hopwood Street Mills, Preston.

Phenol or cresol is condensed with formaldehyde with sodium thiosulphate, or other neutral salt of thiosulphuric acid, as catalyst, thus effecting an economy in formaldehyde, light-coloured products being obtained. In an example sulphur-free cresylic acid is condensed in presence of sodium thiosulphate with formaldehyde which is added in four equal quantities at specified intervals. The product is separated from the aqueous layer and may be diluted with solvents for use as a varnish or may be incorporated with fillers and hardened, for use for example as electrical insulation.

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PAMPHLETS.

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THE CHEMICAL NEWS,

VOL. CXXVI. No. 3290.

VALENCY AND RADIATION.

By F. H. Loring.

The octet theory of valency is so satisfactory in most cases as to lead one to conclude that it represents a truth. The Bohr atom, on the other hand, fits in so well with many experimental facts of spectrum analysis that one is compelled to regard this theory as also true in the main; but there is a conflict between these two theories in that the latter, as is well known, involves electrons revolving in planetary orbits round a central sunlike nucleus; while the octet theory, though it in no way necessitates the electrons being at absolute rest, does imply that they cannot circulate in orbits round a central positive nucleus. How, then, are these theories to be reconciled with each other?

Since the Bohr theory is founded on the spectrum of hydrogen, it might be assumed that with one comparatively free electron outside the nucleus, as in the case of the hydrogen atom which is more easily ionised than helium on this account, it would be free to absorb energy and express it potentially in orbital revolution; then give it up as radiation when settling into "stationary" or steady states of revolution in orbits representing less energy, and when this occurrence takes place it involves multiples of energy or quanta hz, where h is Planck's constant and z is the frequency of the radiation.

When, however, other elements having atoms of more complex structure are considered, difficulties occur both in the Bohr theory and in its reconciliation with the octet theory. These difficulties have been fully realised by chemists and physicists, and several suggestions have been made to meet the difficulties arising therefrom, such, for example, as—

1.—The electrons in their octets vibrating in their mean positions of equilibrium, yet retaining their "corner" positions approximately.

2.—The electrons revolving in small orbits round axes emanating from the corners of the cube.

3.—In the case of helium, the electrons vibrating in semi-circular tracks round a nucleus.

4.—The electrons, in the case of hydrogen only, revolving in circular and elliptical orbits round a nucleus.

Now it will be seen that if these views—taken in a reverse order—are, as it were, plotted, they fall into line, for the first "plot" (4) is a circle or ellipse, the second (3) is a semi-circle, while the third (1) is a more restricted vibration and No. 2 is ruled out. This observation is probably not a significant one, but the transition shown has a good inverse parallel in the three states of matter: solid, liquid and gaseous. Similarly, in considering valency, it is well to remember that the "stationary" state—so to speak—is in this case one in which a certain geometric stability has been reached.

In the whole domain of science involving energy considerations, incompatibilities of these kinds appear. The quantum theory and the ordinary theory of radiation are in conflict at one extreme, while they blend at the other. The theory of relativity negatives certain ideas of Newton which have been thoroughly established for many years. Here, too, at the extreme of great differential speeds, the two theories are in conflict, the Einstein theory giving the correct answer in this case. At the other extreme where slow speeds are involved, either theory will give the correct answer, *i.e.*, the introduction of the relativity theory does not modify the calculations arrived at by the Newtonian method—the classical mechanics. In valency problems the same conflict exists, and in certain cases the answer is the same by either theory, *e.g.*, the ordinary valence theory or that centred round the octet theory, but the latter seems to include the former, that is to say it is not necessary to change theories in passing from one extreme to the other.

One point might be made here, and that is that the reason for this conflict possibly lies in the overlooking of some important factor common to the conflicting theories; and which, if appreciated, would help to clear up matters. First order fractional atomic weights were cleared up by isotopes, although calculations had been made to show how the mass might become "fractioned," as it were, by energy conditions. The discrepancies between Newtonian calculations and observed motions of bodies—electron emissions and the planet

Mercury—have been cleared up by Einstein's theory, which formulates the relative view of necessity involved in the electron case, and similarly in the case of Mercury, but with more elaboration as space physics—so to speak—enters into these problems. The octet theory clears up outstanding difficulties of the older theories.

Now Bohr, in the later developments of his theory, claims that the octet scheme involving the sharing of electrons can be considered in terms of electron orbits so arranged as to unite the atomic nuclei substantially as they are bound according to the static theory. "In fact, the tendency seems towards a Rutherford-Bohr-Lewis-Langmuir atom"—as stated in my *Atomic Theories*, page 137. It is profitable for everyone to become interested in the problems that are engaging the attention of many of the leading scientists of the world.

COMPRESSIBILITY, INTERNAL PRESSURE AND ATOMIC MAGNITUDES.

By Theodore W. Richards.
Wolcott Gibbs Memorial Laboratory, Harvard University.

The object of this paper is primarily to evaluate the respective bulks of the atoms of elements in combination, from the study of the compressibilities of the individual elements and the contraction which occurs during combination. The outcome led also to many other considerations concerning the forces which hold molecules together in the solid and liquid state. The following points in particular are emphasised.

1. Internal pressure is defined for the purpose of the present article as the pressure exerted by the force of affinity, either chemical or cohesive.

2. Bridgman's pressure-volume relations for elements, experimentally determined as far as 12,000 atmospheres, are shown to be represented roughly by hyperbolas of the general type: $(p+P)(V-B)=K$. P and K increase and B diminishes with increasing external pressure, but the simple equation just given serves as a sufficient approximation for the present purpose, since with great pressures these contrary changes partly counterbalance one another. P indicates internal pressure; B is a function which represents the fact that the atom is less compressible than a perfect gas would be under the same conditions of pressure, volume and temperature. In such substances as copper, gold, etc., both P and B are very large.

3. It is shown that Bridgman's values for the pressure-volume relations of potassium and sodium are very similar, the difference being chiefly due to the fact that sodium possesses a much higher internal pressure than potassium. Therefore it is legitimate to use the sodium values as a continuation of the potassium curve. In this way a curve corresponding approximately to the equation $(p+25{,}800)(v-0.20) = 20{,}650$ for the compression of 1.000 cc. of potassium from zero to perhaps 40,000 atmospheres external pressure.

4. From my own values for the compressibility of chlorine, bromine and iodine, and Bridgman's for phosphorus trichloride, similar (although less trustworthy) curves for chlorine and bromine are constructed. These, like the curves of all other polyatomic substances of low boiling-point, are much more flexed than the potassium curve. The reasons for this greater flexure are indicated. The chlorine curve is extrapolated by means of the equation $(p+5{,}300)(v-0.50) = 2{,}650$, which corresponds to the curvature under the highest pressures employed experimentally.

5. The above equations, which give a reasonable picture of the compression of these solids and liquids and are probably capable of moderate extrapolation without great risk, give a new approximate means of estimating internal pressures.

6. From these curves, reduced to a gram-atom basis, taking account of the internal pressures as indicated by the equations in the several combinations, the volumes of these components in combination and the atomic diameters in the salts, as compressed by the mutual affinities, were computed. The atomic diameters thus computed are given in the following table in comparison with earlier values which I computed by an entirely different method, also depending upon the same fundamental idea.

Atomic Diameters.

	New values.	Earlier values.
Potassium, in chloride	3.46	3.5
Potassium in bromide	3.56	
Sodium in chloride	2.85	2.9
Sodium, in bromide	2.92	
Chlorine, with potassium ..	2.82	2.8
Chlorine, with sodium	2.78	
Bromine, with potassium ..	3.04	3.1
Bromine, with sodium	3.03	

7. The compressibility of the products, calculated from these considerations, corresponds as closely as could be expected with the actual compressibilities of the compounds in question. This fact confirms the results of the extrapolation of the curves. Otherwise, the extrapolation might seem excessive.

8. The outcome furnishes a striking quantitative confirmation of the theory of atomic compressibility, which has been a subject of so many earlier contributions, and supports this theory in every respect, affording important aid in throwing light upon the nature of the atoms. This theory which was first advanced in its present form in 1901, *maintains that the chief cause of* changing atomic volume is change of internal pressure. In different chemical combinations atoms must be subject to very different pressures from the several mutual affinities which bind them together. Hence their bulk must depend chiefly upon the magnitude of these pressures, and upon the compressibility of the elements concerned. The investigation is being continued, and highly interesting further results have already been obtained.—(*From the Proceedings of the U.S. National Academy of Sciences*, 1923, IX., 73.)

THE DETECTION OF TRACES OF STIBINE.

By Edward J. Weeks, B.Sc., F.C.S.

In some work on the preparation of stibine it was found necessary to devise a method by which slight traces of this substance could be detected quickly without using the mirror test.

The following method was found to show the presence of stibine in a gas, even when it was only present to the extent of 0.05 per cent. by volume.

According to H. Reckleben (*Ber.*, 1909, XLII., 1458-1464) the action of stibine on silver nitrate is as below:

$$SbH_3 + 3AgNO_3 = Ag_3Sb + 3HNO_3$$

$$Ag_3Sb + 3AgNO_3 + 3H_2O = 6Ag + H_3SbO_3 + 6HNO_3$$

The silver is deposited as a black precipitate.

Hence a glass tube was taken with a diameter of about 5 mm. and about 20 cm. in length. A drop of silver nitrate was inserted in the tube and allowed to run down the sides so as to moisten the inside of the tube. The experimental gas was then passed through the tube, and a brown stain was produced at once, even when only a trace of stibine was present.

Sir John Cass Institute,
April 25, 1923.

GENERAL NOTES.

THE MINERAL PRODUCTION OF NEW SOUTH WALES.

Mr. A. Simpson, H.M. Trade Commissioner at Sydney, has forwarded to the Dept. of Overseas Trade a statement of the mineral production of New South Wales for 1922.

It is stated that the value of the output of minerals for the year has been ascertained to be £14,274,770, an increase of £266,122 compared with the previous year, mainly owing to renewed activity on the Broken Hill Field.

The aggregate value of all minerals won to the end of 1922 is £350,113,801.

Coal, Coke, and Oil Shale.

The quantity of coal wrought during the year amounted to 10,183,133 tons, a decrease of 610,254 tons compared with 1921.

The output of oil shale for the year is 23,467 tons, valued at £60,641; a decrease of 9,022 tons and £16,739 in value compared with 1921.

The diminished smelting operations at Newcastle and Lithgow had a very serious effect on the coke manufacturing industry, the production for 1922 being 240,229 tons, valued at £382,926 as against 592,097 tons, valued at £1,029,694 during the previous year.

Gold.

The aggregate of gold won in the State up to the end of 1922 amounted to 14,873,939 ounces fine, valued at £63,180,442. The production for 1922 showed a further diminution, the yield being 25,222 ounces fine, valued at £107,139. Dredging operations contributed approximately one half of the yield for the year, the principal gold producing mining divisions being Gundagai £18,028, Canbelege £16,000, Adelong £15,915, Hill End £11,706, and Araluen £3,155.

The yield for 1922 represents less than 1 per cent. of the total value of the mineral production of the year, and this branch of the industry is steadily declining in favour of mining for economic minerals.

Silver, Lead, and Zinc.

This branch of the industry is rapidly becoming normal. Many of the Broken Hill Mines were in active operation throughout the year, and production was greatly in excess of 1921. The value accruing to the State from the products of the silver, lead and zinc mines for 1922 amounts to £3,731,566, an increase of £2,120,747 compared with 1921.

The closing down of the Sulphide Corporation Works at Cockle Creek has resulted in a decreased output of silver and lead (pig), and a corresponding increase in the despatches of ore and concentrates for treatment at Port Pirie.

The quantity of ore raised on the Broken Hill Field was 640,064 tons, an increase of 22,731 tons on 1921.

The output from the Yorrandorie field is valued at £64,630, an increase of £14,056.

Copper.

The value of the output of copper for 1922 was £36,233, a decrease of £5,034 compared with 1921. Practically all the important mines remained closed during the year, but as the market is showing an upward tendency, an augmented production may be recorded for 1923.

Tin.

The value of the tin ores produced in 1922 is £154,698, or a decrease of £8,753 compared with 1921.

Tin mining was restricted on account of low markets and high costs, and in the New England district dredging operations were also retarded by lack of water. If the present price of tin is maintained, the output for 1923 should show a marked advance.

Ironstone.

The production of pig iron from the New South Wales ores amounted to 54,856 tons, which represents a considerable decrease. Hoskins Iron and Steel Company, Ltd., at Lithgow, were partly closed during the year. Prospecting operations are being carried on by this company on large areas in the Goulburn, Cunning, Queenbeyan and Juena Divisions.

In addition, 988 tons of ironstone, valued at £1,274, were raised and used by smelting companies for fluxing purposes.

Of iron oxide, 1,381 tons were raised and used for the manufacture of pigments and by gas companies for purifying purposes.

Limestone.

Of Portland cement, 187,800 tons were manufactured during the year from limestone raised in the State representing an increase of £14,466 in value as compared with 1921.

The output for other minerals is as follows:—Alunite £740, arsenic £14,818, asbestos £11,418, bismuth £939, chrome £1,095, clay £13,464, diamonds £1,300, dolomite £800, magnesite £3,231, manganese £7,194, marble £1,900, molybdenite £320, opal (noble) £15,150, platinum £1,182, silica £5,577, sundry minerals £6,942.

Owing to the low prices ruling there was no production of antimony, scheelite, nor wolfram, and only small quantities of bismuth molybdenite were obtained.

Mining for chrome, dolomite, magnesite, manganese, and silica was very seriously affected by the reduced operations carried on by the iron and steel works.

GERMANY'S POTASH AND NITROGEN INDUSTRIES.

Since April 6 the Potash Syndicate has introduced a small price reduction. This is of little avail from the viewpoint of increasing sales. The general opinion is that the reduction of coal prices is too slight to cause reduction in potash prices. It is also thought that a reduction of potash prices would hardly bring about a revival of business, as the agricultural industry, expecting further declines, holds back its orders.

The position of the potash works will soon necessitate short time working. Many works are already on short time, and probably during the next few months will have to work on stock to a greater extent than ever. Accumulation of stock entails heavy expenditure. Proceeds derived from export are no longer so considerable as formerly, and thus do not afford the necessary compensation. The rock salt business, which used to bring in considerable sums to the works, is at a complete standstill. Credit is limited and the complete closing down of works can only be avoided if the necessary working capital is obtained, and nothing remains, therefore, but to have recourse to the open market.

With regard to nitrogen, it appears that since 1913 the German consumption of nitrogen has doubled. During the last financial year, German agriculture required 365,000 tons of nitrogen, *i.e.*, 12.2 kilos for every 2.47 acres. These arrangements for increasing the productivity of German agriculture, which have been reflected in har-

vest results, had only become possible by making German nitrogen requirements more independent of foreign sources. The Haber Bosch process used by the Badische Anilin und Sodafabrik and brought to its highest technical perfection, put an end to the former monopoly of saltpetre.

At the present time the Leunawerk works are still fully employed, but anxiety is felt for the future. Statements to the effect that the demand for sulphate of ammonia has greatly diminished and has even come almost to a standstill have been confirmed.

FAST DYES.

New Record Claimed for a Lancashire Process.

A dyeing process discovered in Lancashire laboratories achieved what is claimed to be a record test during the Drapery and Textile Exhibition, recently held at the Agricultural Hall, London.

For a fortnight, cambrics, piques, ratines and zephyrs in various pinks, blues, reds, greens, and other shades were boiled in a mixture of strong soap and soda water. Not one, as a result of this strenuous treatment, showed signs of fading.

The test began on the Monday the Exhibition opened, and the materials were boiled continuously. The colours are all made by British dyemakers, and this process leaves them, for the entire life-time of the material, absolutely fast to boiling, bleaching, sunlight and seaside air.

UNIVERSITY OF LEEDS.

Chemistry Professorship.

Dr. R. W. Whytlaw-Gray, O.B.E., Ph.D., Fellow of University College, London, was appointed Professor of Chemistry at the University of Leeds as from October 1 next, in succession to Professor Arthur Smithells, F.R.S. Dr. Whytlaw-Gray was educated at St. Paul's School, London, and at University College, London. From 1900 to 1902 he worked under Sir William Ramsay on a redetermination of the atomic weight of nitrogen. This work was completed in the laboratory of Professor Richard Anschutz in the University of Bonn. On his return from Germany in 1906, Dr. Whytlaw-Gray was appointed on Sir William Ramsay's staff at University College, London, and in 1908 he became Assistant Professor. While on the staff of University College, Dr. Whytlaw-Gray conducted important investigations on the physical constants of gases, and was associated with Sir William Ramsay in the well-known work on radium emanation (niton). This work involved exceptional experimental difficulties, less than one-tenth of a cubic millimetre of the gas being available. With this almost infinitesimal quantity Messrs. Ramsay and Whytlaw-Gray succeeded in determining its physical properties, thus proving that the emanation belonged to the helium family of elements. In connection with this very delicate work, Dr. Whytlaw-Gray constructed a specially designed balance, which was sensitive to 1/250 thousandth of a milligramme. Since 1914 Dr. Whytlaw-Gray has been science master at Eton College. During the war he also acted as civilian chemical adviser to the Chemical Warfare Committee, and devoted all his spare time to research on the chemical problems involved in gas warfare. This work has been continued and extended since the Armistice, and the results of his investigations have been exceptionally important.

CERAMIC DEPOSITS OF SASKATCHEWAN.

A considerable amount of interest is being displayed by ceramic experts in the numerous deposits of valuable clays to be found in the Province of Saskatchewan—these ranging from the lower grades used in the manufacture of bricks and tiles to a kaolin which, it is claimed, burns as white, if not whiter, than the British product.

In this connection the Provincial authorities have secured, through the Saskatchewan Bureau of Labour and Industries, the services of a fully-qualified ceramic engineer, in the person of Professor W. G. Worcester, who is engaged in the compilation of data for the perusal of prospective investors. Although the investigations made up to the present are only in their initial stages, the Saskatchewan Bureau of Labour and Industries is desirous of bringing the information already compiled to the attention of British clay-workers, and has, therefore, sent over to the High Commissioner for Canada in London a bulletin on the Clays of Saskatchewan, which it is

thought may interest parties in Great Britain likely to be willing to undertake development work in this field in Western Canada.

The article in question, with accompanying photographs, may be consulted at the office of the High Commissioner for Canada, 19, Victoria Street, London, S.W.1.

DRUGS REQUIRED IN SWITZERLAND.

H.M. Consul-General at Zurich (Mr. Ernest G. B. Maxse, C.M.G.), reports that a firm of wholesale and retail druggists in Schaffhausen, is desirous of purchasing pharmaceutical and druggists' specialities; or preferably of securing the representation for Switzerland of British manufacturers of such goods.

Application for further particulars regarding this enquiry should be addressed to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1, quoting reference 19094/FW/CC.

PHOTOGRAPHIC MATERIALS FOR ECUADOR.

His Majesty's Consul-General at Quito (Mr. R. C. Michell) has transmitted a report on the market for photographic materials in Ecuador, a copy of which may be obtained by British firms upon application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. No. 905/2/F.G./C.C.)

F.B.I. AND RAILWAY RATES.

The question of railway rates came before the Grand Council of the Federation of British Industries on April 18, when Sir Eric Geddes presided.

The following resolution was passed:—

"That the President be authorised, acting in consultation with the Transport Committee, to lodge an application with the Railway Rates Tribunal for a general reduction of rates, to take effect on August 1, if, at any time, he should consider that the situation demands such action."

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Papers read at the meeting on Thursday, April 26:—

W. A. Bone, F.R.S., D. M. Hewitt, and D. T. A. Townend.—*Gaseous Combustion at High Pressures. Part III.: The Energy-absorbing Function and Activation of Nitrogen in the Combustion of Carbon Monoxide.*

It is shown that nitrogen can no longer be regarded as an inert gas in the combustion of carbon monoxide, because when present as a diluent in a mixture of $2CO + O_2$ undergoing combustion in a closed vessel under high pressure it exerts a peculiar energy-absorbing influence upon the system, far beyond that of other diatomic diluents (e.g., excess of O_2 or CO) or even of argon. This influence (*a*) retards attainment of maximum pressure, and (*b*) diminishes maximum temperature attained in explosion, in a much greater degree than can be accounted for on the supposition of its acting merely as a diatomic diluent.

The energy so absorbed by nitrogen during the combustion period is slowly liberated as the system cools down after attainment of maximum temperature, and consequently the rate of cooling is greatly retarded for a considerable time. These effects are very marked in the case of a carbon monoxide-air mixture $(2CO+O_2+4N_2)$, and much more so in that of a mixture $(2CO+O_2+6N_2)$, undergoing combustion under high pressures. In consequence of such energy-absorption, nitrogen becomes chemically "activated" in such explosions, remaining so for a considerable time after attainment of maximum pressure, while slowly reverting to its normal condition. Whilst in this "activated" condition it will combine with oxygen, forming oxides of nitrogen.

If no nitrogen be present in the mixture exploded (*e.g.*, in an undiluted mixture $2CO + O_2$), carbon monoxide burns in oxygen at high pressures almost (but not quite) as rapidly as does hydrogen. Indeed, it would appear as though the usually considered "slow-burning" character of carbon monoxide as compared with hydrogen is not so much inherent in the gas itself as it is conditioned by the presence of nitrogen in the burning mixture.

There is no correspondingly large (if any) energy-absorbing effect (other than purely "diluent") when nitrogen is present in hydrogen and oxygen mixtures similarly undergoing combustion, and there is no evidence of nitrogen being then activated. Indeed, the presence of even a small percentage (two or three) of hydrogen in a carbon monoxide-air mixture undergoing combustion is sufficient to prevent any material activation of the nitrogen. It would thus seem as though the peculiar influence of nitrogen in $2CO + O_2$ explosions is due to its ability to absorb the particular quality of radiation emitted when CO and : O (but not when CO and $:OH_2$) react; such radiation is known to be of a different wave-length from that emitted during the flame-combustion of hydrogen. In other words, there seems to be some constitutional correspondence between CO and N_2 molecules, whereby the vibrational energy (radiation) emitted when the one reacts with :O is of a quality readily absorbed by the other, the two acting in resonance.

R. A. WATSON WATT and E. V. APPLETON, D.Sc.—*On the Nature of Atmospherics.* Communicated by Sir Henry Jackson, F.R.S.

The paper describes observations with a cathode ray oscillograph, on the temporal variations of the electric force occurring in radio telegraphic atmospherics. It is shown that approximately faithful reproduction of the field changes can be assured by using a highly damped antenna whose time constant is kept much less than the duration of the atmospheric.

The principal constants of six hundred typical atmospherics, of which five hundred were delineated by an "eye and hand" method, are examined. A bare majority are quasi-periodic, consisting normally of one complete oscillation, of duration 2,000 micro seconds, the mean change of field being 0.128 volts per metre, with no marked unbalanced transport of electricity on the whole group.

A second group of almost equally frequent occurrence consists of aperiodic impulses, of duration generally about 1,250 micro seconds, but frequently reaching 0.025 of a second, the mean change of field being 0.125 volts per metre, with a seven to one numerical predominance of discharges tending to carry negative electricity to earth in the receiving antenna.

The form of the aperiodic type of atmospheric is shown to include a period of growth to maximum field strength whose duration is little short of the decay period.

I. MASSON, D.Sc., and L. G. F. DOLLEY. —*The Pressures of Gaseous Mixtures.* Communicated by Prof. F. G. Donnan, F.R.S.

Measurements have been made at 25° of the compressibilities up to 125 Atm. of ethylene, argon, oxygen, and a series of binary mixtures of these.

The volume of a compressed mixture usually exceeds the sum of the separate volumes of its two components, the excess depending on the molecular ratio of the two gases chosen and upon the pressure. Thus with an equimolecular mixture of argon and ethylene at 80 Atm. the volume is greater than the additive value by 24 per cent. At a given pressure there is an "optimum" composition, and with a given composition there is an optimum pressure. Oxygen-ethylene mixtures behave quantitatively in the same way as argon-ethylene; oxygen and argon when mixed show a negligible volume increase, and are individually equally compressible.

It is further shown that the pressure of a mixture at high densities exceeds the sum of those measured for the separate constituents; at moderate densities it is definitely less. The former occurrence is due to the actual space filled by the molecules; the latter is due to a mutual cohesion between each. The significance of this was discussed.

Papers read in title only:—

T. R. MERTON, F.R.S., and R. C. JOHNSON.—*On Spectra associated with Carbon.*

The spectral changes due to the admixture of helium to vacuum tubes containing carbon compounds, and the conditions for isolating the band spectra associated with carbon have been investigated. In particular the "high pressure CO" bands can be isolated almost completely under appropriate conditions. The "comet-tail" bands are found in vacuum tubes containing helium and carbon monoxide under appropriate conditions.

In the presence of helium the distribution of intensity in the comet-tail bands differs markedly from that observed by Fowler in tubes containing carbon monoxide at very low pressures, and the wave-lengths of the heads of the bands have been remeasured. By the admixture of hydrogen

the comet-tail bands are replaced by a system of triplet bands which have not been isolated hitherto, and the wave-lengths of the heads of these bands have been measured and found to fall into two distinct band series.

In helium containing a small quantity of carbon monoxide a new line-spectrum has been observed under suitable conditions of excitation, and it is believed that this spectrum is to be attributed to carbon.

W. R. Bousfield, F.R.S., and C. Elspeth Bousfield.—*Vapour Pressure and Density of Sodium Chloride Solutions.*

The purpose of the author's was to obtain a standard set of V.P. determinations at 18° C. for aqueous solutions of NaCl at all concentrations. The method employed was to introduce water and the solution into the legs of a V tube surmounting a barometric column of mercury. Special precautions were taken to exclude air. This necessitated the boiling of the solutions so that they became of unknown concentration. The V.P. observations were therefore primarily correlated to the densities of the solutions. To correlate with the concentrations, a complete set of density observations at 18° C. were made on solutions of known concentration accurate to + 2 in the fifth place of decimals.

Incidentally a method of determining molecular weights by combined observations of the density and V.P. of dilute solutions is given.

F. A. Lindemann, F.R.S., and G. M. B. Dobson.—*A Note on the Temperature of the Air at Great Heights.*

The relatively high pressure of the atmosphere above 60 km., which was discussed in a previous paper, would appear to be due to absorption of an appreciable amount of direct solar radiation. Thus there should be a large variation in temperature at these great heights. Various ways in which such a variation might be shown are considered and some evidence of its existence is found.

G. H. Hardy, F.R.S., and J. E. Littlewood, F.R.S.—*On Lindelöf's Hypothesis concerning the Riemann Zeta-function.*

The paper contains a number of necessary and sufficient conditions for the truth of the hypothesis, some stated in terms of the Zeta-function itself, and others in terms of the arithmetical functions which occur in the "lattice-point problems" of Dirichlet and Piltz.

ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on May 4, at 9 o'clock, will be delivered by Frederick Soddy, F.R.S. The subject is *The Origins of the Conception of Isotopes.*

On Tuesday, May 1, Sir Arthur Keith, M.D., LL.D., F.R.S., Sec. R.I., Fullerian Prof. of Physiology, gave a lecture on *The Machinery of Human Evolution: (IV.) Are our Bodies Changing?*

On Thursday, May 3, Prof. J. T. MacGregor-Morris, M.I.E.E., M.R.I., gave a lecture on *Modern Electric Lamps: (II.) Glowing Solids in Gases.*

On Saturday, May 5, Leonard Williams, M.D., M.R.I., will give a lecture on *The Physical and Physiological Foundations of Character.* (Lecture II.).

ROYAL SOCIETY OF ARTS.

On Monday, April 30, the Howard Lecture on *The Development of the Steam Turbine*, was delivered by Stanley S. Cook, B.A. (Cantab.), M.I.N.A., M.I.M. (Parsons Marine Steam Turbine Co.).

THE CHEMICAL SOCIETY.

At the Ordinary Scientific Meeting, held on Thursday, May 3, the following papers were read:—

Change of Properties of Substances on Drying. Part II. H. S. Baker.

The Sodium Salts of Phenolphthalein. H. Bassett and P. Halton.

The Action of Thiosulphates on Cupric Salts. H. Bassett and R. G. Durrant.

The Conditions of Reaction of Hydrogen with Sulphur. Part II.: *The Catalytic Effect of Oxygen.* Part III.: *On the mechanism of the Reaction of Hydrogen with Sulphur and its Catalysis by Oxygen.* R. G. W. Norrish and E. K. Rideal.

Studies of Electrovalency. Part II.: *Co-ordinated Hydrogen.* T. M. Lowry.

Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XX.: *The Rational Study of Optical Properties.* H. Hunter.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

A meeting of the Society was held on Wednesday, May 2, when the following papers were read:—

The Quantitative Determination of Hemp and Wood in Papers containing these two Fibres, by WILLIAM DICKSON, F.I.C.

The Estimation of Fat, Lactose and Moisture in Dried Milks, by H. JEPHCOTT, M.Sc., F.I.C.

The Estimation of Lactose by the Polarimetric and Gravimetric Methods, by A. L. BACHARACH, B.A., A.I.C.

The Melting Point and Iodine Value of Refined Natural D. Camphor, by MAURICE S. SALAMON, B.Sc.

The Presence of Barium and Strontium in Natural Brines, by A. G. FRANCIS, B.Sc., F.I.C.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At a meeting of the Wireless Section, in the Lecture Theatre of the Institution, on Wednesday, May 2, PROFESSOR C. L. FORTESCUE delivered a lecture entitled *The Design of Inductances for High-Frequency Circuits*.

SOCIETY OF GLASS TECHNOLOGY.

The sixth annual general meeting of the Society of Glass Technology was held in Sheffield, on Wednesday, April 18, the President, Prof. W. E. S. Turner, D.Sc., in the chair. The formal business included the election of the following officers to fill vacancies arising according to the "Constitution and Rules" of the Society:—

President: Prof. W. E. S. Turner, D.Sc. (re-elected).

Vice-Presidents: E. A. Coad-Pryor, B.A., W. J. Gardner.

Members of Council: F. F. S. Bryson, M.A., B.Sc., F.Inst.P., Violet Dimbleby, B.Sc., Major G. V. Evers, Col. S. C. Halse, T. Teisen, B.Sc., C.E.

Treasurer: Joseph Connolly (General), Wm. M. Clark, Ph.B. (American).

Hon. Secretary: S. English, M.Sc.

Auditors: Edward Meigh, M.Sc., Dennis Wood, F.S.A.A.

The President's address on *The Year in* [illegible] taken as read, the main business of the meeting being a general discussion on *Works Organisation*. Mr. W. W. Warren (Messrs. Lemington Glassworks, Ltd.) opened the discussion with a paper entitled *Organising for Production from Pot Furnaces*. After a discussion on this paper (which had already been presented at the Newcastle meeting in February), the case for "Tank-furnace works organisation" was presented by Mr. T. C. Moorshead (Messrs. United Glass Bottle Manufacturers, Ltd.), who said that organisation as applied to a manufacturing industry might be defined as a combination of men arranged or distributed in parts or groups with proper officials, managers, and foremen, and so co-ordinated that they were able with the aid of such machines and tools as they might have available, to produce a finished article efficiently. If they could not say assuredly that each of their groups was composed of capable men, each group in charge of a capable foreman, the foremen all capable, and co-operating under a capable superintendent or shift manager, or whatever they might call him; who was responsible? He believed that the man really responsible for the losses in plant efficiency was the active head of the institution. He endorsed the opinion of industrial engineers and efficiency experts who stated that the average manufacturing plant had only 50 per cent. efficiency, and that also 80 per cent. of this tremendous loss of efficiency was due to the manager, or to a lack of proper or efficient management. The difficulties which beset the factory manager every day might all be traced back to inefficiency on the part of the management, and probably to three things:—(1) Lack of foresight; (2) lack of thorough knowledge of the factory operations; (3) lack of initiative. The causes for these losses could be grouped under five headings:—(1) Faulty raw material; (2) poor labour, that is, incapable, indifferent and disloyal employees; (3) poor attendance; (4) large labour turnover, or ratio of men leaving to the number of men on the payroll; (5) machine or mechanical breakdowns.

1.—*Faulty Raw Material*: It was urged that the buyer, or preferably a works chemist, should investigate the sources of supply to make provision for constant and regular supplies, keep a sufficient quantity in store at all times to ensure the factory against shut downs in case of failure of de-

liveries, to analyse frequently the materials for purity, and to see that they came up to specifications.

2.—*Poor Labour* was a difficult problem and should be dealt with at the source.

3.—*Poor Attendance* was a fundamental principle in dealing with their difficult problems to make a man's work interesting. This might be done first of all by being sure that employees understood what they were doing and why. The more they knew about the material they worked with, the better. Weekly managers' and foremen's meetings are held, full and complete records or minutes of which are kept and copies circulated to those who were present. One copy is also sent to the head office.

4.—*Large Labour Turnover*: To prevent the wastage due to this, work should be made agreeable. It was also necessary to regularise it. Every man should be given identity. A great many manufacturing plants were going so far as to make a careful analysis of each piece of work.

5.—*Machine or Mechanical Breakdowns* were the least wearisome cause of efficiency loss. In nine cases out of ten, machine breakdowns were due to lack of foresight; failure on the part of the man responsible for either the operation or upkeep of the particular machine to anticipate troubles; failure to see that spares for vital parts of the various machines were in store, and failure to keep all moving parts properly oiled and the machines clean, all of which brought us back to the human element and organisation.

Mr. Moorshead concluded his paper by emphasising the responsibility that rests on the foremen, and suggested the questions a manager might ask himself in selecting his foreman or determining his capabilities.

Col. S. C. Halse (Messrs. J. Lumb & Co., Ltd.) said that at his works, after installing a set of new machines, they had daily conferences, including everyone really concerned in the output of their machines. By analysing the figures obtained from day to day they had increased production, and were able to trace nearly every bottle dropped on to the conveyer.

THE INSTITUTE OF METALS.

Dr. W. Rosenhain, F.R.S., delivered the thirteenth annual May lecture before the Institute of Metals on Wednesday, May 2. His subject was *The Inner Structure of Alloys*, upon which much debated matter a flood of light was thrown.

Manchester Meeting.

A further meeting of the Institute (the annual autumn gathering) will be held in Manchester on September 10-13. A ballot for the election of Members and Students desirous of participating in this and other meetings will take place on July 12th, the necessary membership particulars being also obtainable from the Secretary, Mr. Shaw Scott, The Institute of Metals, 36-38, Victoria Street, S.W.1.

PHYSICAL SOCIETY OF LONDON.

At the meeting held on Friday, April 27, the following papers were read:—

The Analysis of Bubbles in Glass, by the Research Staff of the General Electric Company, London.

A Simple Regenerative Vacuum Device and Some of its Applications, by H. P. Waran, Ph.D.

Application of the Eötvös Torsion Balance to the Investigation of Local Gravitational Fields, by Capt. H. Shaw and E. Lancaster-Jones, B.Sc.

Demonstrations were given as follows:

An Electromagnetic Inductor, by L. F. Richardson, F.Inst.P.

An Experiment Demonstrating Time-Lag in Vision, by Dr. F. Ll. Hopwood.

At the meeting held on March 23, Alexander Russell, M.A., D.Sc., in the chair, papers on *A New Moving-Coil Galvanometer of Rapid Indication* and *A Thermopile for Measuring Radiation*, by Dr. W. J. H. Moll, University of Utrecht, were read by Mr. R. S. Whipple in the author's absence.

The galvanometer is designed to secure rapid indication and steadiness of reading without unduly sacrificing sensibility. The coil is long and narrow, and therefore of small moment of inertia: the mirror is supported by the wires forming the coil, between which it is slipped, and the coil is supported between an upper and a lower vertical wire, as distinct from strips, made of silicium bronze and put in tension.

The thermopile is designed to be quick-reading and free from zero-errors, as well

as sensitive. The cold junctions are in contact with metal masses which keep down their temperature, and in order that the hot junctions may have small heat capacity the bi-metallic strips composing the thermopile are made of plates of constantan and manganin silver-soldered along an edge, rolled in a direction parallel to the edge into thin foil, and then cut into strips perpendicular to the edge.

Discussion.

Mr. F. E. Smith commented on the strikingly dead-beat character of the indications given by both instruments. He suggested that the thermopile strips might be reduced to even a less thickness than 0.005 mm. by solution in acid. The galvanometer seemed to have been designed to produce what, with a single fibre suspension, would have been an extremely sensitive instrument, but then the supporting wires were put in tension to reduce the period. Would it still be possible in these circumstances to obtain the required sensibility?

Dr. R. T. Beatty recalled the time when it was necessary to work with a bismuth-iron couple of great heat-capacity and an insensitive Thomson galvanometer. Later came the Paschen astatic galvanometer, but this instrument required such heavy protection from stray magnetic fields that few cared to use it. Dr. Moll's improvements should make possible an advance in measurements of the distribution of energy in the spectrum, *e.g.*, in the H and He spectra.

Mr. C. R. Darling suggested that the apparatus might be applied to measure the distribution of energy in the spectrum of a glow lamp.

Mr. J. Guild inquired if the present galvanometer differs materially from that exhibited by Dr. Moll three years ago, and what is the number of junctions per cm. in the linear form of the thermopile. If silicium bronze is similar in its properties to phosphor bronze the tension of the supporting wires of the galvanometer would have a serious effect on the sensibility of the instrument.

Mr. L. F. Richardson said that he thought Dr. Moll's thermopile admirable for indoor use. For work out of doors, where a rock salt cover could not be used and gusts of wind could not be excluded, Mr. W. H. Dines had found it desirable to make the hot and cold junctions of as nearly the same thermal capacity as possible, so that air currents might affect both equally.

Mr. R. S. Whipple, in reply, said that the difficulty of rolling the strips is immense, and Mr. Smith's suggestion as to solution in acid was well worth trying, though there might be difficulties due to unequal chemical action. He agreed that, although there is no instrument as sensitive as the Paschen galvanometer, this is troublesome to use.

A Note on Aberration and the Döppler Effect as Treated in the Theory of Relativity, by CAPT. C. W. HUME, M.C., B.Sc.

In older text-books aberration is explained as due to the compounding of the velocity of light with the velocity of the earth relative to the ether; hence at first sight the phenomenon appears to conflict with the principle of relativity. The paper gives simple methods of treating this problem consistently with the Restricted Principle, and of finding the Döppler effect. In each case the result differs from the non-relativity result by terms of the second and higher orders in v/c.

A demonstration was shown by MR. C. R. DARLING and HON C. W. STOPFORD, entitled *Experiments on the Production of Electromotive Forces by Heating Junctions of Single Metals.*

When a circuit is closed through a junction of a cold metal with a hot piece of the same metal, large E.M.F.'s are often noticed. As example a bare copper wire was connected to the terminals of a galvanometer. The wire was cut at the middle, one of the cut ends heated and brought into contact with the cold end, when a large deflection was obtained. Electromotive forces up to 0.25 volt may thus be produced.

Discussion.

Mr. J. S. G. Thomas called attention to an account of experiments somewhat similar given by Prof. Carl Benedicks in 1920.

Dr. H. Borns said he hardly understood why Mr. Darling was surprised at his strong thermo-electric forces. When he broke his copper wire with a pair of pincers the two ends of the wire would not be strained equally. The one end of his iron rod (and of his graphite rod) was grooved, the other filed to chisel shape. The one end was heated in a gas flame to about 700° C.;

the temperature gradients were very steep, and the conditions were favourable to oxidation and other chemical effects, expulsion of gases (from the graphite), and to pronounced heterogeneity.

Mr. F. E. Smith commented on the extreme difficulty of treating metals in any way without affecting their constitution. In trying to make a junction with E.M.F. as low as 10^{-7} volts he had found it impossible even to cut silver and platinum wires without straining them, and by twisting the wires he obtained a much greater effect. One inference from the omnipresence of thermo-electric voltages is that in the Wheatstone Bridge the galvanometer key ought to be closed before the battery key, contrary to the usual practice.

Dr. D. Owen said that the voltages obtained appeared to be of the order to be expected from thermo-electric currents at contacts of oxides or sulphides of the metals. Had the authors tried the effect with platinum?

Dr. J. A. Harker said that in using the Callendar-Griffiths Bridge some years ago to measure the resistance of copper wire, he had found that if the wire were asymmetrically heated two different values of its resistance were obtained for the two directions of the current through the bridge. The two values drifted further apart with lapse of time. Lord Kelvin regarded the phenomenon as a modified form of the Kelvin effect.

Mr. R. S. Whipple asked whether the E.M.F. obtained is affected by the pressure at the junction. If the effect is chemical, the compression would affect the thickness of any film formed.

Dr. E. H. Rayner said that thermo-electric currents were formerly dealt with very briefly in the text-books. He would like to know how the subject is now handled in the class-room.

Dr. F. Ll. Hopwood said that information bearing on the subject of the demonstration could be found in the published writings of Richardson and Benedicks.

A demonstration of *The Double Refraction due to Motion of a Vanadium Pentoxide Sol, and Some Applications*, was given by Mr. R. H. Humphry, M.Sc.

The effect was first noticed in 1915 by Freundlich, Dieselhorst and Leonhardt. In linear flow the liquid behaves in the same way as a plate of uniaxal crystal cut parallel to the axis and placed with axis parallel to the direction of flow.

The field between crossed nicols was shown to light up near an obstacle interposed in a stream of the liquid. Similar effects due to efflux of the sol from a jet, to the convective stream from an electrically-heated wire, etc., were also shown.

Discussion.

Mr. E. Hatschek said that the experiments called for exceptional cleanliness as the sol is very sensitive to electrolytes. Aniline blue is interesting in that it gives colour effects; it has a well-marked absorption band, and behaves like a positive crystal to wave-lengths on one side of the band, but like a negative crystal, to wave-lengths on the other side.

Mr. R. W. Paul asked whether the effect of subjecting the liquid to an electrostatic field had been tried.

Mr. J. Guild said he was not satisfied as to the cause of the double refraction. The colloidal particles are too large to have the effect of molecules, and too small to be regarded as transmitting light after the manner of glass dust. In his reading of ultramicroscopic literature he had come come across nothing which suggested a satisfactory explanation. In interpreting the appearances obtained by Prof. Coker's method the greatest caution is necessary. The intensity of the effect of a strain or a streamline depends on its direction, and for certain directions it is impossible to detect a strain at all.

In reply to the discussion Mr. Humphry said that the experiments which were shown were only to be regarded as preliminary, and no interpretation of the observed effects had yet been attempted. It seemed possible by use of this effect to throw more light on stream line problems; and with better apparatus, designed to overcome any tendency towards gelation, useful results might be obtained. The effect of an electric field on the arrangement of the particles had been worked out by Freundlich (Kapillar Chemie, 1922), who also explained the production of the double refraction. It is true that with stationary nicol prisms certain stream lines are accentuated while others may not appear at all; but this difficulty would be overcome by having rotating nicols. The more delicate means of examining polarised light might show effects which were missed with nicol prisms.

PHYSICS IN INDUSTRY.

The fourth of the series of lectures on this subject, which are being delivered under the auspices of the Institute of Physics, will be given by Dr. J. W. Mellor, of Stoke-on-Trent, and will deal with *The Application of Physics to the Ceramic Industries*.

Sir J. J. Thomson will preside at the lecture, which will be delivered in the hall of the Institution of Electrical Engineers, Victoria Embankment, W.C.2, on Wednesday, May 9, at 5.30 p.m.

A ticket of admission will not be required.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Design of Inductances for High-Frequency Circuits, by Professor C. L. Fortescue, Member.

This paper consists of an investigation of the proportions and the arrangement of the winding of high-frequency inductances in order to obtain the minimum ratio of R/L Both stranded and solid wire coils are dealt with, and the unavoidable limitations arising from the space-factor are considered. Results and tables are given which enable simple comparisons to be made between stranded and solid wire coils having either single- or multiple-layer windings.

CORRESPONDENCE.

CAUTION TO INVENTORS.

To the Editor of The Chemical News.

Sir,—In case the matter may not have been brought to your notice already, I should like to draw your readers' attention to the *Caution to Inventors*, which has been inserted by the Comptroller-General of Patents in the Illustrated Official Journal at the request of the Chartered Institute of Patent Agents:—

"Inventors are advised to beware of suggestions such as are now being issued from a German source to the effect that, for reasons obscurely stated by the German writer, the British inventor should co-operate with him, and in particular should send him by registered letter a sum of money. The communication is fraudulent, and on no account should money be sent."

I am,

Yours faithfully,

Richard B. Pilcher,

Registrar and Secretary.

The Institute of Chemistry,

30, *Russell Sq., London, W.C.*1.

April 18, 1923.

ARABIAN ALCHEMY AND CHEMISTRY.

To the Editor of The Chemical News.

Sir,—Perhaps you will be good enough to allow me to answer the letters of Mr. Whale (March 9), and Mr. Redgrove (April 6), on the question of Geber. I would first make it quite clear that the sole conclusive proof of the identity of Geber with Jabir ibn Hayyan, the famous and historical Muhommedan chemist of the 8th century, would be the discovery of Arabic originals of the Latin works; up to the present this discovery has not been made. I have briefly outlined my position in an article in *Nature* (Feb. 10, 1923), to which, and to the valuable letter of Prof. J. R. Partington in the following number of the same journal, perhaps Mr. Whale and Mr. Redgrove will refer.

There are, however, one or two additional facts which may be of interest: (1) *Geber* is an accurate transliteration of the Arabic *Jabir*, especially as in Egypt and many other parts of the Muhammadan world the letter *j* (*j i m*) is sounded as hard *g*; (2) according to Darmstaldter, *Die Alchemie des Geber*, Berlin, 1922, p. 134, Vincent de Beauvais in cap. 82 of his *Speculum Naturale*, Nürnberg, 1485, refers to Geber as Jeber; (3) in mediæval Latin chemical works Geber is often called Geber ebor Haen, which is undoubtedly a transliteration of the Arabic Jabir ibn Hayyan; (4) Boerhaave (1668-1738), professor of chemistry at Leyden University, says in his *Elementa Chemiæ* (Shaw's English translation, 3rd edition, 1753, vol. I., p. 26, footnote, that Golius (1596-1667), professor of mathematics and Arabic at the same University, presented Arabic MSS. of Geber to the Leyden public library, and translated them into Latin; the translation was, he says, published at first in folio and afterwards in quarto, under the title of *Lapis Philosophorum*. From Boerhaave's description of this translation (*loc. cit.*) it is

clear that the work, if not actually the *Summa*, at least bears the closest similarity to it. But the *Summa* and other Latin works were already well known, and had been studied for some three hundred years. Why, therefore, should Golius go to the trouble of translating them from the Arabic unless to provide a more accurate text? It seems to me that the importance of this observation of Boerhaave's is very great. At the same University as Golius, and practically contemporary with him, his information must almost certainly be reliable; he knew the *Summa* and other Latin works and the presumption that Golius' translation is of Arabic originals of these seems overwhelming. If it were otherwise, surely Boerhaave would have mentioned the fact. It is tantalising to find that the Leyden library, if Boerhaave is correct, must have lost these manuscripts, as there are now in it none which can be regarded as originals of the Latin works. However, fresh discoveries of Arabic MSS. are continually being made, and one may hope that other copies of the works translated by Golius may be forthcoming in the future.

(5) The names of many works attributed to Geber correspond with titles of works of the Arabic Jabir ibn Hayyan, as given in the *Kitab at Fihrist* and elsewhere; example (a) *De claritate alchemiæ* with *The Book of Spendour*, (b) *Testamentum Geber* with *The Testament of Jabir*, (c) The *Summa* with the *Compendium*. Unfortunately Arabic texts of these are not yet known.

On the desirability of making translations of all the extant Arabic writings of Jabir ibn Hayyan, I am in entire agreement with Mr. Redgrove and Mr. Whale. I feel, however, that translations without texts are always unsatisfactory, but since publishers are very reluctant to undertake the expensive business of having Arabic type set up, there seems to be no alternative. I have in hand a translation of the *Book of Properties*, from the British Museum MS., and hope to publish a great part of it in a forthcoming book on *Chemical Theory and Practice in Islam*, which I am preparing for the Trustees of the Gibb Oriental Translation Fund.—I am, Sir,

Yours, etc.,

E. J. HOLMYARD.

Clifton College.
April 19, 1923.

LABORATORY ENQUIRY.

To the Editor of THE CHEMICAL NEWS.

SIR, — Could any of your readers supply me with the address of a laboratory that would make up a sample from a formula?

I am, Yours, &c.,

NORMAN URWIN.

3, Percy Avenue, Catchgate, Durham.
April 19, 1923.

NOTICES OF BOOKS.

Wavelength Tables for Spectrum Analysis, by F. TWYMAN, F.INST.P. Pp. VIII. + 106. London: Messrs. Adam Hilger, Ltd., 75a, Camden Road, N.W.1. 1923. Price 7s. 6d. net.

This comprehensive treatise is not, as the title conveys, a monotonous page-sequence of tables, difficult of reference and with jumbled data. Instead, it is a first-class text-book of interesting matter, of inestimable value to the analyst.

Referring to the author's preface, it comprises standard wavelengths from 2375 to 8495 I.A., the persistent and sensitive lines of most of the elements arranged under the name of each element, and the most persistent and sensitive lines rearranged in order of wavelengths. The last chapter deals with wavelengths useful in the determination of stellar radial velocities.

In his explanatory matter, the author has rightly paid much attention to the results of Hartley, Pollok, Leonard, and A. de Gramont, briefly showing records of their respective works, and carefully tabulating their data. In a short appendix, the condensed spark produced by means of the Hemsalech coil (quoted frequently by the authorities mentioned above) is described collectively with the requisite observations.

The value of this book is not to be estimated, and we recommend it highly to the notice of our readers. It should run to many editions.

The Phase Rule and Its Applications, by ALEXANDER FINDLAY, M.A., PH.D., D.Sc., F.I.C. Fifth edition. Pp. XVI. + 298. London: Longmans, Green & Co., Ltd., 39, Paternoster Row, E.C.4. 1923. Price 10s. 6d. net.

In the course of the rapid development of the various sections of Physical Chemis-

try, in recent years, increasing attention has been paid by investigators to the study of heterogenous equilibria. This has necessitated a very complete revision of some of the chapters of Professor Findlay's classical text-book on the Phase Rule, which we are pleased to note is now in its fifth edition.

Certain sections have been re-written, and much new matter (including 24 fresh diagrams) has been incorporated. The graphical methods, especially those initiated by Jänecke, of representing multi-component systems, have been widely used. They are fully explained for the benefit of students and others not familiar with this mode of expressing results.

Doubtless the present revised edition of this volume in the important series of text-books on Physical Chemistry, edited by Sir William Ramsay and Prof. F. G. Donnan, will be as widely and assiduously studied as its predecessors.

The Destructive Distillation of Wood, by H. M. Bunbury, M.Sc. (Bris.), B.Sc. (Lond.). Pp. XIX. + 320. London: Benn Brothers, 8, Bouverie St., E.C. 1923. Price 35s. net.

Whilst the destructive distillation of coal has been the subject of numerous treatises, very little attention has been paid to the thermal decomposition of wood. This is somewhat surprising in view of the fact that the distillation of wood comes next in importance to that of coal.

Mr. Bunbury's book is therefore very welcome. In it he has given a good description of the plant and processes used in the distillation of various types of wood. This is followed by a survey of the products of these thermal decompositions and the conditions influencing their respective quantities and composition.

The treatment of the technical aspects of the subject has been well done, and whilst modern processes are adequately described, obsolete methods receive historical mention only.

In the immediate future such processes as the thermal decomposition of wood will receive much more attention than they have hitherto commanded, especially when it is realised that waste wood can be successfully treated.

The information contained in Mr. Bunbury's book will be found of value to industrial chemists and others interested in this subject. It is a contribution to the chemistry and technology of distillation which deserves, and will doubtless obtain, a place in all scientific and technical libraries.

PUBLICATIONS RECEIVED.

Nitrate Facts and Figures, 1923, compiled by A. F. Brodie James, F.S.S London: F. C. Mathiesons & Sons, 16, Copthall Ave., E.C. 5s. net.

This is the twentieth year of issue of these statistics, which tend to show that the period of depression in the nitrate industry has passed. The near future seems very hopeful.

Mysore Agricultural Calendar, 1923. Price 1 anna.

This publication contains much useful information for those interested in its 54 pages. That agricultural problems are of a scientific nature is clearly indicated by a perusal of the various methods outlined to combat pests.

The Official Handbook, issued by The British Association of Trade and Technical Journals, Ltd. London: Silician House, Southampton Row, W.C.1. Pp. 102. 1923. 1s. net., is full of most interesting data concerning the advertising facilities offered by technical journals.

The restoration of trade rests, to some extent, with the creation of a revitalised market-interest. Prior to the war, British chemicals were in a general state of prosperity, but a damaging cautiousness is extant among purchasers now. To overcome such an attitude, manufacturers must make judicious use of industrial publications, and this is the object of the publishers of the *Handbook*: to advise and keep advertisers in their campaigns—large or small.

Much important information bearing upon these points is enclosed in the prefaces. The book is, in fact, a complete and concise means of reference for all firms who are planning publicity schemes in 1923.

W. Heffer & Sons, Ltd., Publishers, Cambridge, have in the press a volume entitled *The Expert Witness*, by C. Ainsworth Mitchell, M.A. (Oxon.), *Editor of The Analyst.*

This book is written on similar lines to and is in many respects a sequel to the author's "Science and the Criminal," which is now in its second large edition. It gives an outline of the latest applications of scientific research to the investigation of criminal problems, and also an account in non-technical language of the use of expert evidence of all kinds, illustrated by reference to old and modern trials.

The nine chapters deal with the latest methods of identification by means of patterns on the feet; by the pores of the skin; by the detection of latent prints on paper, etc.

The latest scientific methods of handwriting are also described, and an outline is given of the author's methods of estimating the age of ink in writing. In the description of Secret Writing there is an account of the scientific evidence given at the trials of German spies.

The last chapter deals with expert evidence in art and with the application of such scientific methods as the use of X-rays to identify old masters.

Messrs. Baillière, Tindall & Cox, 8, Henrietta St., Covent Garden, W.C., state that the price of Mr. T. Thorne Baker's *The Spectroscope and Its Uses in General Analytical Chemistry*, published by them, and reviewed in *The Chemical News*, this vol., page 253 (April 20), is 8s. 6d., and not 7s. 6d. as originally given by them.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

9522—Bakelite, Ges.—Manufacture of condensation products from phenols and aldehydes. April 6.

9405—Casale, L.—Synthetic production of ammonia. April 5.

9374—Farbwerke vorm. Meister Lucius Bruning.—Converting hydrocarbons, etc., into others containing a higher number of carbon atoms. April 5.

9369—Naugatuck Chemical Co.—Manufacture of diphenylguanidine. April 5.

Specifications Published this Week.

195113—Smythe, R. H.—Process to facilitate classification of mineral particles and to reduce losses in ore dressing by the aid of chemical substances.

173237—Westinghouse Lamp Co.—Process for the preparation of coherent masses of the rare metals and alloys and oxides thereof.

173757—Gerb-und Farbstoffwerke, H. Renner & Co., Akt-Ges.—Manufacture of salts of sulphonated coumarone resins.

195295—Pedemonte, A. L.—Manufacture of pure alumina.

Abstract Published this Week.

193269—Chlorinating organic compounds.—Boake, Roberts & Co., Ltd., Carpenters Road, Stratford, London, and Silberrad, O., Silberrad Research Laboratories, Buckhurst Hill, Essex.

The chlorination of organic compounds, more particularly of such compounds as are chlorinated with difficulty by ordinary methods, is carried out by means of sulphuryl chloride in conjunction with aluminium chloride and sulphur chloride. The last reagent may be omitted if substances, such as sulphur and carbon bisulphide, capable of yielding sulphur chloride under the conditions of reaction are present. An example describes the chlorination of p-dichlorbenzene to yield tetrachlorbenzene with lesser amounts of tri- penta- and hexachlorbenzene. The chlorination of anthraquinone, indanthrene, and naphthalene and its derivatives is also referred to.

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3291.

NOTES ON THE INDIAN INDUSTRIAL REVIVAL.

It is apparent from the various pieces of news received that India is undergoing a revival on a large scale in the chemical industry. Some idea of this progress will be gathered from the following notes, compiled from authoritative sources:—

Bengal.—Dr. Bose's Laboratory, Ltd., have erected a plant at Belliaghata for the extensive production of sulphuric acid. The plant is of the S. Carves type, and manufactures 7 tons per day. The company anticipate an output of hydrochloric and nitric acids later. At Kumardhubi, large fireclay and silica works have just arrived at completion, drawing their material from adjacent deposits. A process for the manufacture of glass from an anhydrous sodium sulphate present locally has been adopted by the Belliaghata Glassworks, and this will render output more cheap and of better quality.

Bombay.—Mr. C. B. Amoula and Dr. A. N. Meldrum have experimented in the manufacture of rennet casein (*Journ. Indian Indus. Lab.*, 1923, III. (i), 95), and more than 22 cwts. have been transported to England for the determination of its commercial value.

Central Provinces.—At Wardha, a new feature is presented by Messrs. Ranade & Co., who are producing a red oxide paint of high quality.

Madras.—The Godavari and Kistna districts are under examination for the production of sodium carbonate and the general utilisation of alkaline deposits. Dr. Marsden, the industrial chemist for the Presidency, has issued his report and opinions for Government consideration. The factories under construction for the Kerala Soap Institute, Calicut, should be completed in May, and its gross profits are estimated at Rs. 12,500 per annum.

United Provinces.—The proprietor of the Nawab Sugar Factory at Shahabad (Hardoi District) is in negotiations for the purchase of an up-to-date sugar refinery, and the termination of the deal will furnish a long-felt want. The Shr-Waha Lakshmi Sugar Corporation (Kheri District) has followed suit, and is cultivating adjacently on a wide commercial basis. Applications and representations have been made for the formation of a new company called "The Lyallpur Sugar Co., Ltd., Cawnpore," with the considerable capital of five lakhs of rupees.

J.M.

A STUDY IN RHYTHMIC SERIES OF CHEMICAL CHANGES.

By K. C. Viraraghava, M.A.

The phenomenon of the appearance of one of the products of a reaction in a homogeneous or heterogeneous system, in a periodic instead of a continuous manner, has been noted in many cases, and the classical Liesegang phenomenon is the most studied. Various authors have interpreted it differently. There are the super-saturation theorists, adsorption advocates, and electrolyte coagulationists.

A gel is not essential for the production of this phenomenon. When aspirin is heated just to its melting point and allowed to cool, it solidifies in the form of concentric rings round a circular centre, the thickness of the rings gradually increasing from the centre outwards. Nor is the phenomenon confined only to a solid, or liquid, or their combined phase.

A series of experiments, "*on the formation of the rhythmic bands by the interaction in narrow tubes of such gases as ammonia* with hydrogen chloride, hydrogen bromide and hydrogen fluoride; and hydrogen sulphide with chlorine or sulphur dioxide, has been described by Koenig.

The typical *rhythmical reactions so far* studied are as follows:—

Homogeneous Systems.

(*a*) The evolution of carbon monoxide by the action of sulphuric acid on formic acid.

(*b*) The evolution of carbon dioxide from super-saturated solutions.

(*c*) The action of nitric acid on a mixture of sulphuric acid and formic acid.

(*d*) Super-saturated sodium thiosulphate and alum solutions.

(*e*) The solidifying of melted aspirin.

Heterogeneous Systems.

(*a*) *Involving the alternate formation and decomposition of a protective film.*

(1) The decomposition of hydrogen peroxide in the presence of a clear film of mercury.

(2) The interaction of calcium carbonate and acetic acid.

(*b*) *Involving slow diffusion.*

(1) Silver chromate in gelatin.

(2) Lead chromate or iodide in agar.

(3) Lead carbonate in silicic acid.

(4) Interaction of mercurous nitrate and sodium formate in agar.

(5) Hydrochloric acid with sodium chloride in gelatin.

The reactions which take place on some such base as a gelatin or agar-agar layer, are very complete. The concentration of the reacting solutions, temperature, light, impurities, *e.g.*, chlorine, the method of preparing the gel, the age and nature of the gel, peptisation, all influence the course of the reactions.

In all these reactions diffusion plays an important part, for instance, in the Liesegang phenomenon potassium chromate or dichromate must have been distributed in the gel and must have reached a certain equilibrium when the sol had set. When new forces are set up, *e.g.*, by introducing silver nitrate, equilibrium is upset, and counter influences are at work between silver ion and chromate radical. It is not known if the chromate ion exists, but certainly silver chromate is precipitated. Silver chromate is seen when silver nitrate solution is added to the gel. What, then, diffuses? If it is silver nitrate, it must pass through the ring of silver chromate, like copper ferro-cyanide in a porous pot. Silver chromate will then function as a semipermeable membrane in the gelatin structure. H. M. Fischer and D. McLanglin have found that all substances which give satisfactory Liesegang rings are impermeable toward molecularly dissolved substances and consequently it would seem unlikely that after the formation of the first ring a second and third ring could be formed.

It has been said that the chromate also diffuses. Only as a resultant of the diffusions of chromate and nitrate is the precipitate formed in periods. In an experiment the lower portion of a gel was completely deprived of its chromate before the reaction completed.

Hugh McGuigan has observed that the chromate is fixed, and remains so, unless an attraction force is exerted. The silver nitrate wanders on through the ring into the clear zone until it is sufficiently close to the chromate gelatin to exert an attraction which again draws the chromate and forms another ring and clear zone. At the same time the chromate exerts a pull on the silver, and the ring is formed where the forces are balanced.

Dr. J. N. Friend has put forward the suggestion that colloidal silver chromate is first formed and the organic emulsoid gelatin retards the rate of precipitation, but all the same, diffusion continues until the colloidal particles have grown too large and then begin to precipitate out. He considers that the distance between the rings is therefore the algebraic sum of the rates of diffusion and precipitation. Dhar and Chatterjee have observed that peptisation is an important factor in the phenomenon of periodic precipitation. Possibly the insoluble silver chromate is in a finely dispersed state, and as they go on diffusing, they grow in size and precipitate out. But Williams and Mackenzie have experimental evidence to infer that silver chromate did not function as a protected colloid with a slow rate of diffusion, and diffused only like a crystalloid. The precipitation followed the usual rules of solubility product.

With regard to circular disposed precipitation, W. Moeller concluded that the structure of the gel is the main factor. Gelatin jellies contain two substances, one of which, *α-gelatin*, forms a structural network and the spaces in this are occupied by *β*-gelatin, which is structureless. Rhythmic changes in the structure of the fibrillar network are suggested to be responsible for the separation of foreign substances in rhythmically distributed layers. According to him, Liesegang rings are not dependent on chemical interaction of substances after diffusion through a jelly medium. Forces are called into play which indirectly determine a rhythmical alternation in the coagulation of the dispersed phase.

But Prof. H. T. Brown believes that two opposing diffusive streams of reacting substances produce a rhythmical series of zones and bands which follow the contours of surfaces of equidensity. Apparently all bands contain particles of the same density. The size of the particles may also differ between the bands, and the differentially deposited particles might show colour differences. It has been said that the colour of dispersoids differs with the size of the particles.

In many of my experiments the rings came out with intervals in a regular rhythmical manner, but, after some time, beyond the range of the rings but contiguous

to them, several bands in thin films were deposited continuously with different colours. It has been observtd that, when the concentration of the two reagents approximate to equality, the precipitate appears to be continuous, but under the microscope it is seen to be finely banded. Even with the naked eyes, the alternate-coloured continuous bands can be seen on the gelatin layer. Possibly, when there is the difference in concentration, the rings appear and at the stage when the concentrations equalise, the precipitate is formed in a continuous manner. The different colours need to be explained.

The suggestion has already been made that the existence of quanta is not limited to energy alone. Just as matter has been considered for centuries to be discontinuous it may be its reactions, too, are of a similar nature.

THE SIGNIFICANCE OF THE EXPERIMENTALLY DETERMINED CRYSTAL STRUCTURES OF THE ALKALI POLYHALIDES.

By George L. Clark.[1]

Jefferson Physical Laboratory, Harvard University.

By means of a new and powerful method of X-ray analysis the crystal structures of some of the alkali polyhalides have just been determined by the writer in association with Professor William Duane. Both the details of the method and of the analyses have been presented in other notes.[2] It is the purpose of this note to bring the new experimental data to bear upon the great uncertainty concerning the real constitution of these unique compounds which has prevailed since their discovery 30 years ago by Wells and Wheeler.[3]

Few experimental facts concerning the alkali polyhalides have been known up to the present time, except that solutions of cesium iodide, for example, are able to dissolve iodine, or bromine or chlorine, and produce crystals whose chemical analyses may be expressed by the empirical formulæ CsI_3, CsI_5, $CsIBr_2$, $CsBrI_2$, $CsICl_2$, CsIBrCr, etc. Wells and Penfield[4] found that the trihalides crystallise similarly and may even be isomorphous. Stability measurements by the writer and by Ephraim[5] show that the trihalides form a remarkable continuous series, in which maximum dimensions of the atoms are favourable to stability: thus CsI_3 is most stable, while $CsCl_3$, KBr_3 or NaI_3 do not exist; and KI_3, $RbBrI_2$ and $CsBr_3$ are all equally stable. These measurements also indicate very clearly that all salts which contain iodine form one stability and crystallographic series, and those containing bromine in the absence of iodine another; in other words, the heaviest halogen atom has a defining influence, so that such a formula as $CsBrI_2$ might more properly be written CsI.BrI.

It has been suggested that in the alkali polyhalides the metal may have a higher primary valence, as is true of gold (which is in the same periodic group as the alkali metals) in the known reaction $Au+Cl + Cl_2 = Au{+}{+}{+}Cl_3$. Again, it has been advocated by Remsen,[6] Wells and Penfield,[4] McCombe and Reade[7] (in February, 1923), and others, that one or more of the halogen atoms have a higher valence than is true in the simple halides. Several experimental facts disprove these contentions. Freezing point and conductivity experiments show that the ions in a solution of CsI_3, for example, are $Cs+$ and I_3-. This means that in a molecule of the trihalide the single primary valence bond which holds cesium and iodine together in CsI is unchanged, but that the iodide ion is able to associate with itself two additional atoms of iodine, or a halogen *molecule* capable of independent existence, and form complexes. In solution the equilibrium between $I- + I_2$ and $I.I_2-$ is very definitely established. Besides the complex anions of the halogens, those of sulphur, $S.S{-}{-}$, $S_2S{-}{-}$, $S_3S{-}{-}$, $S_4S{-}{-}$, and $S_5S{-}{-}$, have been identified by Küster,[8] and those of tellurium, $TeTe{-}{-}$ and $Te_3Te{-}{-}$ in the beautiful work of Kraus.[9] These are all manifestations of secondary

[1] *National Research Fellow.*

[2] *Clark and Duane, Proceedings U.S. Acad. Sci.*, 1922, VIII., 90.

[3] *Wells and Wheeler, Zs. anorg. Chem.*, 1892, I., 442.

[4] *Wells and Penfield, Amer. J. Sci.*, 1892, XLIII., 21, 475.

[5] *Ephraim, Ber. deut. chem. Ges.*, 1917, L., 1,069.

[6] *Remsen, Amer. Chem. J.*, XI., 291.

[7] *McCombe and Reade, J. Chem. Soc.*, 1923, CXXIII., 141.

[8] *Küster, Zs. anorg. Chem.*, 1905. XLIII., 53; 1905, XLIV., 431; 1905, XLVI., 113.

[9] *Kraus, J. Amer. Chem. Soc.*, 1922, XLIV., 1,216.

valence just as truly as the combinations of water with salts to form hydrates or of ammonia to form ammines (cationic complexes) are secondary valence phenomena. These experiments, however, cannot explain the structure and the real nature of these complex groups, and they cannot be interpreted so as to give concrete knowledge of secondary valence. The actual crystal structures give this information unmistakably, and in addition answer many questions which are confronting chemists, such as whether or not the identity of the single chemical molecule is retained in the space lattice of a solid.

The crystal structures of four alkali polyhalides have now been more or less completely determined. The results are as follows:

KI_3 monoclinic	$d_{100}=4.70 \times 10^{-3}$ cm.
CsI_3 orthorhombic	$d_{100}=4.49$, $d_{010} = 6.43$, $d_{001} = 7.02\times10^{-8}$ cm.
$CsIBr_2$ rhombohedral	$d_{100}=4.26$, $d_{010} = 5.91$, $d_{001} = 6.90\times10^{-3}$ cm.
$CsICl_2$ rhombohedral hexagonal	d (Cs to I along trigonal axis)$=6.102\times10^{-8}$ cm.

Of these, the first three have been studied by the writer[2] and the last by Wyckoff.[10]. In spite of the fact that three crystallographic systems are represented, the exceedingly interesting result comes out that all four crystal structures present precisely the *same* relative arrangement of atoms in the unit parallelopipeda, if these unit cells are properly oriented so as to include one molecule. It is of secondary importance for the purpose in hand that the unit cell plenes may be perpendicular or inclined to each other, or that the axes may be equal or unequal in length. This arrangement is as follows: metal atoms at the corners of the cell, and halogen atoms inside the cell *in a line* on the body diagonal, with the heaviest halogen atom at the centre and the other *two on the diagonal on either side* equidistant from the centre (if they are alike). In CsI_3 and $CsIBr_2$ the distance from the centre along the diagonal of the two iodine or two bromine atoms is half that from the centre to the corner; hence the co-ordinates are $(a/4,\ b/4,\ c/4)$ and $(-a/4,\ -b/4,\ -c/4)$, where a, b, and c are the edge lengths of the unit cell in three directions at right angles. In $CsICl_2$ the chlorine atoms have a parameter of 0.19 of the total length of the diagonal on either side of the central iodine atom, so that the unit cell is a rhombohedron instead of a rectangular parallelopiped. It is an interesting conjecture whether the orthorhombic variety of $CsICl_2$, if it does exist, is produced by a displacement of the chlorine atoms farther along the diagonal from the centre. The only other possibility would be that a chlorine atom occupies a central position instead of the iodine, but this should be very much less stable than the other arrangement. There is no doubt but that the normal tendency of the compound is to form the rhombohedral hexagonal form.

In KI_3 the unit cell is a monoclinic prism which has been formed by the slight deformation of a cube. The parameter of the two non-central iodine atoms on the body diagonal is slightly less than 0.25 (approximately 0.23) of the total length of the diagonal.

Thus in every case experimentally observed the three halogen atoms are closely associated together in a line, and constitute a singly acting group in the space lattice just as truly as they do in the formation of complex anions in solution, and just as truly as the identity of the complex cation $[Ni\ (NH)_6]^{++}$ is perfectly maintained in the space lattice of crystals, as proven by the crystal structures of nickel halide and nitrate hexammoniates determined by Wyckoff.[11] There is every reason to believe that the facts discovered for the four typical polyhalides are also true of all other polyhalides, since they are so closely related crystallographically and chemically. At least it is practically certain that the relative arrangement of atoms in the unit cells is the same. The experimental proof that the heaviest halogen atom is central in the halogen group is entirely compatible with the facts also experimentally observed that salts containing iodine form one stability and crystallographic series and bromine another. Differences in the polyhalides therefore arise only in the size and

[10] *Wyckoff, Ibid.*, 1920, XLII., 1,100.

[11] *Wyckoff, Ibid.*, 1922, XLIV., 1,239, 1,260.

shape of the crystal unit cell, and in most cases even the latter is the same.

While it is clear that the secondary valence group of the polyhalides, as well as those of ammines and hydrates, maintains its individuality in the crystal space lattice, it is still a question whether the whole molecule of KI_3, for example, exists as such in the space lattice. It has been clearly demonstrated that the simple chemical molecule Na-Cl as it is found in vapour does not exist as such in the crystal lattice, since every sodium atom is surrounded at the corners of an octahedron by chlorine atoms, and every chlorine atom similarly by six sodium atoms. On the other hand, Bragg[12] has shown conclusively that the single molecules of organic substances, and perhaps of some inorganic compounds, are retained intact in the lattice, and that the actual symmetry of single molecules is the determining factor of crystallographic symmetry. Thus a single completely assymetrical molecule in a unit cell can produce only the asymmetrical triclinic system; the higher symmetry of the monoclinic and orthorhombic systems is attained by placing 2 or 4 or 8 whole asymmetrical molecules in the unit cell properly oriented about planes or centres of symmetry. As a sort of middle ground between the lattices of sodium chloride and of organic compounds, there may be cited the examples of the hexammoniates of the nickel halides[11] and the hexahydrate of zinc bromate.[13] In the single molecule of $Ni(NH_3)_6Cl_2$, six molecules of ammonia are bound to the nickel atom by secondary valence forces, and the two chlorine atoms by primary valence bonds. In the crystal lattice each nickel atom is still surrounded symmetrically by six ammonia molecules, but there are not two but *eight equidistant* chlorine atoms in the same way that there are six chlorine atoms around each sodium atom in sodium chloride. The compound $Zn(H_2O)_6BrO_3$ is exactly analogous.

It cannot be denied that the forces which hold organic molecules fixed in crystal lattices, or which enable very long molecules lying parallel to form liquid crystals, or which cause the molecules of almost all organic substances to become very definitely oriented in suraces, are the same kind of forces which hold electrically neutral molecules of ammonia or water to metal atoms, either in the single molecule or in the crystal lattice. Now it has been proven that precisely the same thing is true of the halogen groups in polyhalides, even though the forces are holding together three atoms, or even more, of the same chemical nature, instead of grouping neutral atoms or molecules around a central atom of greatly different nature.

If planes are drawn through the lattices of the four experimentally studied trihalides so as to enclose 1/2 instead of one molecule, then the metal atoms and the heaviest (previously body-centred) halogen atoms appear alternately at the corners of the new unit, while one atom of iodine in KI_3 or CsI_3, one atom of bromine in $CsIBr_2$ or one atom of chlorine in $CsICl_2$ lies on the body diagonal at 0.46 or 0.50 or 0.38 of its length from a corner iodine atom. Hence the structures are remarkably closely related to the simple halide unit cubes. A halogen atom in the latter case is replaced by a polyhalide group. Dimensions are changed and perfect cubic symmetry destroyed, but every metal atom is surrounded by six complex halogen groups, each acting as a single point in the lattice. The single primary valence bond of the chemcal molecule is split in the lattice, but the secondary valence group within itself is retained intact.

It has already been stated that the stability of the alkali polyhalides depends upon the metal—as a matter of fact relative stabilities are directly proportional to the atomic volumes of the metals. This is now easily explained. The size of the metal atom in the lattice determines the dimensions of the unit cell, or the interplanar distances, other things being equal. The smaller the dimensions the more difficult it is for three halogen atoms to lie on a straight line within the cell with any degree of stability. Halides of potassium are just able to form polyhalides; as a matter of fact only the iodide is able to form such compounds sufficiently stable to isolate. The size of the potassium atoms and the interplanar distances are such that upon the formation of KI_3 the string of iodine atoms predominates, the frame-work of the potassium atoms is distorted unequally in different directions, and the resultant properties approximate those of elementary iodine crystals. The compound NaI_3 does not exist because, even if the I_3 groups were

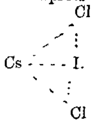
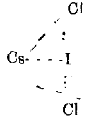
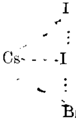
[12] *Bragg, J. Chem. Soc. (London), Dec.*, 1922, CXXI., 2,766.

[13] *Wyckoff, Amer. J. Sci.*, 1922, IV., 188.

compressed in the lattice, the attraction of two iodine atoms under these circumstances far outweighs the ability of the sodium atom to hold three iodine atoms in spatial distribution. The equilibrium between I- + I_2 and $I.I_2$- holds just as truly in the formation of solid crystal lattices as it does in ionised solution. Hence even in the very stable CsI_3 the reaction is easily sent from right to let by the application of mechanical compression or by increasing kinetic energies of vibration by means of heat.

The newly determined crystal structures of the trihalides present interesting evidence bearing upon the general question of *the additivity of atomic radii.* In the case of CsI_3, for example, the diagonal along which lie 1 atom of cesium and 3 atoms of iodine has a length of 10.6×10^{-8} cm. This is appreciably smaller than the sum of 1 cesium diameter plus 3 iodine diameters as evaluated under different assumptions by Bragg, Richards, Davey and others.[14] Hence the I_3 group must be very considerably compressed so that the atoms may be pictured as flattened in the direction parallel to the crystal cell diagonal into a shape something like that of red blood corpuscles. The experimental results are further proof of the validity of the conception of compressible atoms so long advanced by Professor T. W. Richards and of the incorrectness of the hypothesis of constant atomic radii.[15]

It is interesting to note that it is possible to prepare CsI_5. Wells and Penfield[4] claim that the crystals are triclinic. If this is true it may be safely predicted upon the basis of the present analyses, that the lines joining the two iodine atoms on each side of the centre to the central iodine atom *will intersect at an angle.*

Finally, it may be asked whether any formula can express the constitution of the alkali polyhalides. It is obvious that none can express all the facts. The X-ray data gives the only absolute picture of the constitution of the solid state. The nearest approach to a mechanical formulation would express the empirical formula $CsICl_2$ as . The dotted lines mean not an increase in the number of primary valences for cesium, but a split one. The expression shows the halogens bound together by secondary valences, with the heaviest halogen at the centre, so that a singly acting unit is produced; and yet each single halogen atom also comes under the direct influence of the metal atom. Otherwise it would be difficult to explain the mechanism whereby $CsICl_2$, prepared by passing chlorine into a solution of CsI, should decompose into CsCl and ICl. It is of course perfectly natural that the strongest halogen should remain hound to the metal. Furthermore, by a simple consideration of balance, the formula shows why  should be, and is, more stable even than . Even with these advantages, however, the formula falls far short of expressing correctly all the facts which crystal structure determinations have revealed.

—*(From the Proceedings of the U.S. National Academy of Sciences.)*

[14] *Clark, Science*, 1922, LV., 491.

[15] *Cf. also Wyckoff, U.S. Acad. Sci., Feb.*, 1923., IX., 33. *The radius of the chlorine atom calculated from* $CsICl_2$ *is unusually small, as it should be, since it is measured along the diagonal in the direction of greatest compressing forces. For this reason the direct application of this dimension to other chlorine compounds has little meaning.*

GENERAL NOTES.

CANADIAN AGRICULTURAL FAIRS.

It is the custom in Western Canada to hold, during the summer months, at important centres, a series of agricultural exhibitions and fairs. At these shows, which are attended by the general public as well as trade representatives, and at which all classes of goods appealing to the farming community are exhibited, the majority of

the exhibitors have, in the past, been Canadian and American firms.

These exhibitions should afford an opportunity of familiarising traders and consumers in Western Canada with the productions of U.K. firms. Arrangements have been made by the Dept. of Overseas Trade for participation by H.M. Trade Commissioner in Western Canada in the fairs to be held at Brandon, Edmonton, Regina and Vancouver in July and August.

At each a Bureau of Information will be maintained by H.M. Trade Commissioner, at which it is desired to display copies of leading U.K. trade and technical journals, particularly those dealing with agricultural and allied matters. The Trade Commissioner proposes not only to display such journals, but to distribute them in suitable quarters, and would therefore be glad to receive up to 50 copies each of journals dealing with agricultural implements and machinery (including stationary engines, tractors, dairy supplies and machinery, grinders, crushers and feed cutters, residential electric lighting plants, etc.), mining, engineering (including wire rope, pulleys, etc.), telephones, mechanics' tools for farm and workshop, municipal equipment, ships' fittings and ship chandlery, and marine engines; and about 20 copies of other trade journals.

CZECHO-SLOVAKIA'S EXPORTS FOR THE FIRST QUARTER OF 1923.

Following are the values exported according to class of goods during the period January to March:—

	Millions Kč.
Wood, coal and fuel	495
Sugar	352
Cotton, yarns, etc.	344
Wool and woollen goods	245
Glass and glassware	191
Iron and ironware	143
Corn, flour, malt	136
Leather and leather goods	63
Flax, jute, hemp	57
Paper and paper goods	54
Ready-made clothes	51
Earthenware	44
Chemicals and chemical products	32
Machines and apparatus	28
Minerals	30
Wooden ware	23
Imitation stones and goods thereof	29

The greatest increase took place in the export of wood and coal, which in March reached a total value of 187 million crowns. The textile industry also had a favourable month; cotton products of a value of 98 millions, and woollen goods of a value of 81 millions were exported. In spite of the difficult situation prevailing in the glass industry, the latter was able to export glassware to a value of 64 million crowns. The export of iron has been steadily increasing since the beginning of the year, and in January the export of iron and iron goods amounted to 34 million crowns; in February the export rose to 50 million crowns, and in March a further increase of 59 millions took place.

Germany and Austria again take first place as purchasers of Czech goods; no less than 40 per cent. of the total exports going to these countries in the first quarter of this year. England occupies third place with a total of 282 million crowns.

TOWN REFUSE AS MANURE.

The Ministry of Agriculture and Fisheries has just issued a leaflet drawing the attention of farmers and others to substitutes for stable manure, which is now becoming very scarce. Among the various possibilities is to be reckoned ashpit refuse, which is available in large quantities but is at present used to a very limited extent. Town authorities are now disposing of their refuse in a better way, and some are adding other wastes and crushing the whole for use as a fertiliser.

The amounts of ashpit refuse available over the country are very large. It is estimated that no fewer than 10,000,000 tons per annum are produced in England and Wales, while in London alone the production is estimated at 1,500,000 tons per annum. Broadly speaking, town refuse has given successful results in two cases:—

(*a*) On heavy-land farms or allotments, where it is used for root crops, cabbages, &c.;

(*b*) For raising the level of low-lying wet ground and forming new land which can be used for allotments.

Considerable quantities of town refuse have been used by farmers on the heavy London clay soils of the Home Counties. About 10 tons per acre is a usual dressing; it should be spread before the winter ploughing begins so that it can be well

worked into the soil. It then lightens the stiff soil and facilitates cultivation generally, and good root and other crops are usually obtained. Farmers round some of the larger Scottish towns, *e.g.*, Glasgow, Dundee, Perth, and Aberdeen, use considerable amounts, probably even more than those round London. Uncrushed refuse is sold from Dundee, where the demand is stated to be greater than the supply: the 1921 deliveries are said to have been 39,000 tons.

There are six types of refuse sent out from towns:—

1. "Dry" refuse: the contents of refuse bins and "dry" ashpits.

2. Separated dust: finely divided material separated mechanically from the dry refuse through a ⅜ in. or 5/16ths in. sieve.

3. "Mixed" refuse: the contents of privy middens and ash closets.

4. Night soil: the contents of pails containing crude fæcal matter only; this is produced in towns where the pail system is used. When dried and granulated it contains some 5½ per cent. nitrogen, 5½ per cent. phosphates, and 2½ per cent. potash.

5. Mixed night soil.

Market and slaughter-house refuse are sometimes mixed with 1, 2, 3 and 5.

6. Street sweepings and other wastes.

Of these, street sweepings and unmixed night soils are well known to farmers, and are often easily disposed of. One large London district disposes of its street sweepings at 10s. per ton. Night soil in the dry form, unmixed with ashes, is now sold by a few corporations at about £7 per ton. If the methods used in these places were generally applicable to town and city conditions the problems arising out of the waste of sewage would be solved, and the shortage of organic manures on the farm would be greatly relieved.

In its crude form, ashpit refuse contains a small percentage of cans, bottles, &c., of no use on the farm but indeed constituting a nuisance. In the more progressive towns metals, cinders and bottles, for all of which a use or market can be found, are removed.

The material can be offered to farmers as it stands. Its composition, however, is not particularly good in spite of its smell. Improvement is effected by enriching with a certain amount of other waste matter, such as street sweepings, slaughterhouse refuse, and stable manure. Analysis indicates that these manures have the following approximate composition:—

	Per cent.
Organic matter	25—40
Nitrogen	0.4—0.6
Phosphoric acid (P_2O_5)	0.3—0.5
Equivalent to tricalcium phosphate, $Ca_3(PO_4)_2$	0.7—1.1
Potash (K_2O)	0.3—0.5

In some northern towns it is found possible to add a considerable proportion of night soil in addition to street sweepings, cattle market manure, slaughterhouse refuse and stable manure. An excellent fertiliser is thus obtained, containing one or more per cent. of nitrogen.

The enrichment of the refuse is shown by the fact that the nitrogen content runs as high as 1 per cent., whilst the samples of unfortified town refuse contain only about 0.5 per cent.

It has been proposed to add soot to the town refuse, but this would not be a sound procedure.

These modern prepared wastes are well worth attention by farmers, and trial lots may usefully be put on the root and cabbage land, and possibly also used for hay on stiff clay soils.

REPARATION DYESTUFFS.

The Board of Trade desire to draw attention to the fact that under the Reparation Clauses of the Peace Treaty requisitions are made periodically for the delivery of certain German dyestuffs on reparation account. Information as to the requirements of colour users for dyestuffs which cannot be obtained from British manufacturers is collected by the Colour Users' Association and furnished periodically to the Board of Trade.

In order that this information may be as complete as possible, the Board would be glad if all users—whether members of the Association or not—would furnish particulars of their estimated requirements for German dyestuffs, say once every three months, to the Secretary, Colour Users' Association, Cromwell Buildings, Blackfriars Street, Manchester.

The Inventions Development (1923) Co., of Belfast, has been reorganised. It will continue to carry on its usual business and develop ideas and processes commercially.

The Federation of British Industries has sent a letter to H.M. Government on the question of Inter-Imperial Trade, and urging the early passage of the Empire Cotton Bill, which has been promoted with the intention of safeguarding the cotton industry.

NEW CHILEAN LAW REGARDING THE SIZE OF JUTE SACKS USED IN THAT COUNTRY.

H.M. Chargé d'Affaires at Santiago, Chile, has reported to the Dept. of Overseas Trade that a law was passed by Congress and approved by the Council of State on the 9th February, lifiting the size of jute sacks to be used in transport by human labour.

A translation of the law reads as follows:

Article 1.—The weight of any sack containing any class of product which has to be carried by human labour (man handled) shall not exceed 80 kilogrammes. The contravention of this law shall be punished by a fine of 20 pesos for each infraction. This law will come into force 180 days after the date of its publication in the *Diario Official.*

Transitory Article.—The dispositions of this law will not affect articles which are already packed on the date on which it comes into force.

The measure was introduced into Congress with the object of protecting the workers in the nitrate industry, where the weight of a full sack of nitrate has been 92 kilos.

The importance of the new law lies in the fact that Jute nitrate bags form the chief article of importation into Chile, both as regards quantity and value. Unless it is found commercially possible to utilise the old 92 kilogramme sacks, the new law will therefore presumably result in orders for new jute sacks.

Messrs. Murphy & Sons, Bureau of Bio-Technology, have issued their *Bulletin* No. 9, Vol. II. (March), containing contributions on the following:—

The "Biotec" Comparator.

The Destruction of Structural Timber: its causes and prevention.

The Suppression of Insect Pests and Fungoid Diseases. The Fumigation of Commercial Glasshouses.

Nicotine Petroleum Emulsion.

Micro Organisms in the Leather Industries.

The May issue of *Current Opinion* contains a short but important article upon *The Need for Knowledge.* It is pointed out that very few people could pass a test in any subject outside their own calling, and indeed, few are familiar with the wider aspects of their particular industry or branch.

DRUGS AND CHEMICALS FOR ROUMANIA.

Mr. Szana, British Vice-Consul at Timisoara, reports that a local firm is desirous of purchasing drugs and chemicals from British sources.

The name and address of the firm, together with further particulars, may be obtained by British firms upon application to the Dept. of Overseas Trade.

WEATHER FORECASTS.

The Postmaster-General announces that arrangements have been made in conjunction with the Meteorological Department of the Air Ministry for weather forecasts to be distributed each afternoon to telephone exchanges. The forecasts will cover the period from 6 p.m. on the day of issue till 6 p.m. on the following day. These arrangements came into operation on May 1. The forecasts will be available between 5 p.m. and midnight each day on demand by telephone subscribers, and should be of especial benefit to farmers and other residents in rural areas.

Subscribers on rural party lines will receive the information free of charge, a local call fee being charged in the case of other subscribers. The forecasts may also be obtained by enquirers at call offices on payment of the usual call office fee.

In the April number of *The Journal of the Chemical Society*, pp. 881-884, Dr. Alexander Scott contributes a paper entitled *Isolation of the Oxide of a New Element A Correction.* Dr. Scott states that he submitted the sample of his pale buff-coloured powder ("New Oxide," as described in his communication to the Chemical Society on February 1, an account of which appeared in *The Chemical News*, Feb. 9, p. 81, to Drs. Coster and Hevesy for examination by X-ray spectral analysis. These authorities have failed to find any Hafnium lines in the oxide and in the original New Zealand sand from which Dr. Scott prepared the oxide.

The constituents appear to be oxides of iron, titanium, and traces of other metals all previously known.

Dr. Scott has unravelled the mystery of his results by further analyses, which seem

to indicate that he was dealing with a mixture of K_2TiF_6 and other double fluorides, which would yield a mixture of oxides on ignition by his analytical procedure.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

At the Ordinary Meeting on Thursday, May 3, the following papers were read:—

LEONARD HILL and A. EIDINOW. *The Influence of Temperature on the Biological Action of Light.*

The biological action of light is accelerated by warmth, retarded by cold. This is true for bacteria, infusoria and human skin. The temperature coefficient for infusoria, between 1° and 20° C., is about 3.0. By adequate exposure to cool air over-action of the sun on the skin can be prevented.

F. A. E. CREW. *Studies in Intersexuality. I.—A Peculiar Type of Developmental Intersexuality in the Male of the Domesticated Mammals.* Communicated by Prof. R. C. Punnett, F.R.S.

Papers read in title only:—

E. J. MORGAN and J. H. QUASTEL. *The Reduction of Methylene Blue by Iron Compounds.* Communicated by Prof. F. G. Hopkins, F.R.S.

1. The restoration of the power to reduce methylene blue to boiled milk by means of ferrous sulphate solution is shown to be due to the inorganic constituents of the milk.

2. It is shown that methylene blue is reduced by ferrous sulphate solution in the presence of sodium hydroxide, carbonate, bicarbonate or phosphate and of the sodium salts, such as acetic, tartaric or citric. Ferrous sulphate solution alone will not effect any perceptible reduction.

3. The reduction has been followed quantitatively with the result that it is clear that two ferrous molecules always react with one of methylene blue.

4. The mechanism of the reduction has been studied with a view to throwing light on the biological hydrolytic oxidation-reduction system. It is suggested that the clearest light is afforded by the consideration of the relative affinities of the oxygen acceptor for the hydroxyl ion and of the hydrogen acceptor for the hydrogen ion.

C. F. COOPER. *The Skull and Dentition of* PARACERATHERIUM BUGTIENSE. *A Genus of Aberrant Rhinoceroses from the Lower Miocene Deposits of Dera Bugti.* Communicated by Dr. A. Smith Woodward, F.R.S.

W. L. BALLS. *The Determiners of Cellulose Structure as seen in the Cell Walls of Cotton Hairs.* Communicated by Dr. F. F. Blackman, F.R.S.

The use of plane and circularly polarised light and of immature hairs has enabled further observations to be made more easily. The reversals of the spiral fibrillar structure show their full number, as soon as the secondary wall is visible, indicating predetermination thereof during growth in length. Thus far, however, the primary wall cannot be made to demonstrate such reversals visually; but on development of the pre-cellulose it shows instead a pair of opposed spirals whose pitch corresponds to that of the slip spirals of the secondary wall. These slip spirals are now found to be structurally connected with the quicker pit spirals and invariably opposed to the latter in direction; the tangents of their angles happen to stand in the ratio of 4:1, which suggests polymerisation from the pre-cellulose of the primary wall. The rotation of the plane of polarisation by a single layer of secondary cell-wall is inverted on opposite sides of a reversal point; thus the molecular structures of the right-hand and left-hand areas would seem to be mirror-images.

Attention is called to the low specific gravity of the cell-wall, explicable as a consequence of its spongy structure, and to the uncertainty of any existing determinations thereof. It is also pointed out that correct microscopic definition can only be obtained by the use of an analyser in the eye-piece.

Some tentative conclusions can be drawn, pending X-ray analysis, as to the probable space-lattice conformation of cotton and other celluloses, which bring one effectively to a modernised re-statement of Nägeli's micellar theory.

I. DE B. DALY. *The Influence of Mechanical Conditions of the Circulation on the Electro-cardiogram.* Communicated by Prof. E. H. Starling, F.R.S.

THURSDAY, MAY 10.

Papers read:—

PROF. A. FOWLER, F.R.S. *The Series Spectrum of Trebly-ionised Silicon.* (*Si IV*).

SIR ROBERT ROBERTSON, F.R.S., and W. E. GARNER. *Calorimetry of High Explosives.*

H. S. HOLE SHAW, F.R.S. *Stream line Filter.*

F. W. ASTON, F.R.S. *A Critical Search for a Heavier Constituent of the Atmosphere by means of the Mass-spectrograph.*

Papers read in title only:—

PROF. H. E. ARMSTRONG, F.R.S. *Electrolytic Conduction: Sequel to an attempt* (1896) *to apply a Theory of Residual Affinity.*

PROF. H. E. ARMSTRONG, F.R.S. *The Origin of Osmotic Effects. IV.—Hydronodynamic Change in Aqueous Solutions.*

R. W. WOOD, FOR. MEM. R.S., and A. ELLETT. *On the Influence of Magnetic Fields on the Polarisation of Resonance Radiation.*

W. G. PALMER. *A Study of the Oxidation of Copper and the Reduction of Copper Oxide by a New Method.* Communicated by Sir William Pope, F.R.S.

E. A. FISHER. *Some Moisture Relations of Colloids. II.—Further Observations on the Evaporation of Water from Clay and Wool.* Communicated by Prof. A. Smithells, F.R.S.

THE CHEMICAL SOCIETY.

At the meeting on Thursday, May 10, the Baeyer Memorial Lecture was delivered by PROFESSOR W. H. PERKIN, LL.D., F.R.S., in the Lecture Hall of the Institution of Mechanical Engineers, Westminster.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

ORDINARY MEETING.

Mr. P. A. Ellis Richard, President, in the chair.

A Certificate was read for the second time in favour of Mr. Robert C. Grimwood, A.C.G.F.C., D.I.C., A.I.C.

The following were elected Members of the Society: Messrs. John Myers, F.I.C., John Loudon Buchanan, F.I.C.

The following papers were read:—

The Quantitative Determination of Hemp and Wood in Papers containing these two Fibres, by WILLIAM DICKSON, F.I.C.

The author considers that in the microscopical determination of hemp fibres in the presence of wood, examination alternately by ordinary and polarised light enables one to readily distinguish the mocrostructure of the different fibres. He has devised a method for quantitative work utilising the counting method of Spence and Krauss World's Paper Trade Review, 18th Dec., 1917.

The paper is disintegrated by boiling with dilute caustic soda and the pulp churned up with an egg switch. The fibre is then stained by Cross and Bevan's double malachite green and congo red method, well spread out on the cover slip and mounted in the usual way. The counting is done by Spence and Krauss's method, but no correction factor is required to convert proportions by diameter into proportions by dry weight of furnish.

The Estimation of Fat, Lactose, and Moisture in Dried Milks, by H. JEPHCOTT, M.Sc., F.I.C.

As a result of examining over 25,000 samples of dried milk, it is contended that (1) Moisture is best determined by drying at 102-103° C. for 1 to 2 hours; (2) Fat can most satisfactorily be determined by a careful use of the Werner-Schmidt method. A modified Gerber method gives less accurate but concordant results for rough routine purposes; (3) The polarimetric determination of lactose in milk powders, whilst offering certain advantages, should not be used where great accuracy is desired. In such cases a gravimetric process, based upon the modified Fehling's method of Quisumbing and Thomas, is recommended.

The Determination of Lactose by the Polarimetric and Gravimetric Method, by A. L. BACHARACH, B.A., A.I.C.

Pure α-lactose mono-hydrate was prepared by careful recrystallisation and drying. It was shown to have the value for

$[\alpha]_D^{20}$ of 52.42, agreeing with the most trustworthy recorded figure.

The reducing power of pure α-lactose monohydrate was also determined by the modification of the Fehling method due to Quisumbing and Thomas. The accuracy of this method claimed by these authors was confirmed, but the reducing power obtained was somewhat higher, 0.1000 gm. of lactose hydrate giving 0.1565 grm. of cupric oxide.

The Melting Point and Iodine Value of Refined Natural D-Camphor, by MAURICE S. SALAMON, B.Sc.

The iodine value and melting point of *specially purified d-camphor* have been redetermined, and it is shown that the usually accepted value is too high, and that that the usually published melting point is too low. The iodine value of the specially refined d-camphor is found to be 0.1, and the melting point 179° C. It is concluded that the majority of previous determinations must have been made on d-camphor that was slightly impure.

The iodine value of oil of camphor has also been redetermined, and examples are given of how this value, together with the melting point and iodine value of d-camphor can be used to indicate the percentage of camphor present in a sample of refined d-camphor. This suggested that refined d-camphor for pharmaceutical purposes *should have a melting point not lower than* 176° C. and an iodine value of not more than 0.7.

The Presence of Barium and Strontium in Natural Brines, by A. G. FRANCIS, B.Sc., F.I.C.

The results of the analysis of 7 samples of brines from deep boreholes in Derbyshire, Staffordshire, and Scotland are recorded together with a brief account of the method of analysis adopted. The maximum quantities of barium and strontium chlorides found were 178.2 and 169.4 parts per 100,000 respectively.

An explanation based upon the "permutit" reaction is put forward to account for the presence of chlorides of barium and strontium in natural brines, and it is shown that there is a gradation in the strengths of sodium chloride solutions necessary completely to remove calcium, strontium and barium from a "permutit"- filter charged with these elements.

THE GEOLOGICAL SOCIETY.

At the meeting on April 18, 1923, Prof. A. C. Seward, Sc.D., F.R.S., President, and, afterwards, Dr. Herbert H. Thomas, M.A., Vice-President, in the chair, the list of *donations to the library was read; it included*, among others, the following works: Imperial Institute, Monographs on Mineral Resources, with special reference to the British Empire: Copper-Ores, by Robert Allen, *1923; Mercury-Ores,* by Edward Halse, 1923; Memoirs of the Geological Survey of England and Wales, Explanation of Sheet 169—The Geology of the Country around Coventry, including an account of the Carboniferous Rocks of the Warwickshire Coalfield, by T. Eastwood, W. Gibson and others, 1923; and Memoirs of the Geo*logical Survey, Special Reports on the* Mineral Resources of Great Britain—Vol. XXV.: Lead- and Zinc-Ores of Northumberland and Alston Moor, by Stanley Smith, 1923; and Vol. XXVI.: Lead- and Zinc-Ores of Durham, Yorkshire, and Derbyshire, with Notes on the Isle of Man, by R. G. Carruthers and Sir Aubrey Strahan, 1923.

The following communication was read:

The Structure of the Bowmore-Portaskaig District of Islay, by JOHN FREDERICK NORMAN GREEN, B.A., F.G.S.

Microscope-sections and rock-specimens from the Bowmore-Portaskaig district of Islay were exhibited in illustration of this paper.

At the meeting held on Wednesday, May 2, a lecture was delivered by PROF. JOHN JOLY, D.Sc., F.R.S., F.G.S., on *The Bearing of some Recent Advances in Physical Science upon Geology.*

ROYAL SOCIETY OF ARTS.

On Wednesday, May 9, at the Ordinary Meeting, a lecture entitled *Surface Combustion—with special reference to Recent Developments in Radiophragm Heating,* was delivered by WILLIAM ARTHUR BONE, D.Sc., PH.D., F.R.S., Professor of Chemical Technology, Imperial College of Science and Technology, South Kensington. Mr. D. Milne Watson, M.A., LL.B. (Gas Light and Coke Company) presided.

An experimental demonstration of "Radiophragm" Heating was given by Mr. F. J. Cox, M.Inst.M.E.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the Ordinary Meeting in the Lecture Theatre, on Thursday, May 10, the Faraday Medal was presented to the Hon. Sir Charles A. Parsons.

The fourteenth Kelvin lecture, entitled *Problems in Telephony, Solved and Unsolved,* was delivered by Dr. J. A. Fleming, F.R.S., Honorary Member.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The seventy-first general meeting was held at the house of The Royal Society of Arts on Tuesday, May 8. A paper entitled *Heavy Grade Egyptian Crude Petroleum,* was read for W. A. Guthrie, F.I.C., F.R.S.E., M.Inst.P.T., &c. H. Barringer, M.Inst.C.E., M.I.Mech.E., M.I.N.A., M.Inst.Mar.Eng., presided.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

Pass List for the April Examinations, 1923.

The following Associate has passed the examination for the Fellowship:—

In branch G: Chemical Engineering: Grisenthwaite, Arthur Turner, A.C.G.F.C., B.Sc. (Lond.).

The following candidates have passed the examination for the Associateship:—

In General Chemistry: Brady, Peter Joseph, East London College; Grayson, Harold John, University College, London; Gregory, Louis Wilfred, University College, Nottingham; Loasby, Geoffrey, B.Sc. (Birmingham), Birmingham University; Marrison, Leslie William, East London College; Player, Harold William Victor, King's College, London; Smith, Daniel Agnew, University College, Nottingham; Vineall, George John Charles, B.Sc. (Lond.), University College, Southampton

Seven candidates failed to satisfy the examiners.

THE INSTITUTE OF METALS.

The thirteenth annual May Lecture of the Institute of Metals was delivered on Wednesday, May 2, at Storey's Gate, Westminster, by Dr. W. Rosenhain, F.R.S., of the National Physical Laboratory, who chose as his subject, *The Structure of Alloys.*

Referring to the great accumulation of facts in regard to the properties and microstructure of alloys which have been forthcoming in recent years, the lecturer said that the time had arrived when it was most desirable that there should be found a key to this maze of knowledge in the form of a general theory that would link together the mass of facts into a homogeneous whole. Such a theory he attempted to put forward, basing it upon the intimate knowledge of crystal structure which had recently been acquired by means of the application of X-rays to the study of the arrangement of atoms in crystals. The crystal structures found in pure metals became modified in the case of alloys, particularly in those called solid solutions, where a second kind of atom, the atom of the alloying element, entered into the structure of the crystal and produced in it certain minute changes. With regard to such changes the lecturer put forward two simple principles, and was then able to show a striking series of inferences from his theory, which accorded closely with a large number of experimental facts. Connections between various series of properties in metals and their alloys were established which had not formerly been recognised, such as the relation between hardness and alloying power. Especially important is the connection between the minute distortion of crystal structure which occurs in alloys and their behaviour on melting and freezing, while such phenomena as plasticity, diffusion and others fell easily into line with the same type of explanation. Most important of all, perhaps, is the fact that this new theory of alloy structure affords a ready explanation of the electrical properties of metals and alloys and the changes of those properties when the metal is heated or cooled. These explanations cover the mysterious phenomena of super-conductivity found in many metals when cooled nearly to the absolute zero of temperature.

ROYAL INSTITUTION.

On Tuesday, May 8, Professor A. C. Seward began a course of two lectures on *Ice and Flowers of Greenland,* and on

Thursday, May 17, PROFESSOR COKER delivers the first of two lectures on *Engineering Problems solved by Photoclastic Methods*.

The Friday Evening Discourse on May 11 will be given by PROFESSOR W. A. BONE on *Gaseous Combustion at High Pressures*, and on the 18th by MR. W. M. MORDEY on *Studies in Alternating Magnetism*.

SIR ERNEST RUTHERFORD'S postponed discourse will be given on Friday evening, June 15, and his concluding lecture on *Atomic Projectiles* on Saturday afternoon, June 16.

The Annual Meeting of the members of the Royal Institution was held on Tuesday afternoon, May 1, Sir James Crichton Brown, Treasurer and Vice-President, in the chair. The Annual Report of the Committee of Visitors for the year 1922, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The Report of the Davy Faraday Research Laboratory Committee was read. Sixty new members were elected in 1922, and 63 lectures and 19 evening discourses were delivered. The books and pamphlets presented amounted to about 162 volumes, making, with 426 volumes (including periodicals bound) purchased by the Managers, a total of 588 volumes added to the library in the year. Thanks were voted to the President, Treasurer and Secretary, to the Committees of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year. The following were unanimously elected as officers for the ensuing year:—

President, The Duke of Northumberland.
Treasurer, Sir James Crichton-Browne.
Secretary, Sir Arthur Keith.
Managers, Sidney G. Brown, John Mitchell Bruce, Sir Dugald Clerk, John Ambrose Fleming, Sir Richard Glazebrook, Earl Iveagh, Sir Alexander C. Mackenzie, Robert Mond, Sir Edward Pollock, Alfred W. Porter, Lord Rothschild, Sir David Salomons, William Stone, Sir Alfred Yarrow, the Right Hon. Lord Justice Younger.

Visitors, Sir Harry Baldwin, William A. Bone, Alfred Carpmael, Ernest Clarke, Edward Dent, Thomas W. Dewar, George H. Griffin, W. E. Lawson Johnston, Colonel F. K. McClean, Sir Malcolm Morris, W. Rushton Parker, Walter Peacock, Major C. E. S. Phillips, Hugh Munro Ross, Sidney Skinner.

FUTURE LECTURES.

Friday Evening Discourses, addressed to members and their friends at 9 p.m.

May 11: WILLIAM ARTHUR BONE, D.Sc., F.R.S., M.R.I., Prof. of Chemical Technology, Imperial College, *Gaseous Combustion at High Pressures (New Experiments)*.

May 18: WILLIAM MORRIS MORDEY, PAST PRES.I.E.E., M.INST.C.E., M.R.I., *Recent Studies in Alternating Magnetism (with Experiments)*.

May 25: SIR ASTON WEBB, K.C.V.O., C.B., President of the Royal Academy, *The Development of London*.

June 1: PROF. HENDRIK ANTOON LORENTZ, HON.F.R.S., HON.M.R.I., PH.D. Haarlem University, *The Radiation of Light*.

June 8: MISS JOAN EVANS, B.LITT. (OXON.), F.R.I., Member of Council, St. Hugh's College, Oxford ("Magical Jewels," Clarendon Press), *Jewels of the Renaissance*.

Tuesdays, May 22, 29, June 5: *Discoveries in Egypt*, by W. M. FLINDERS PETRIE, D.C.L., LITT.D., F.R.S., etc., Prof. of Egyptology, University of London.

Thursdays, May 17, 24: *Engineering Problems Solved by Photoclastic Methods;* 1 (1) *Improvement in Apparatus*, (2) *Contact Pressures and Stresses;* 2 (1) *The Testing of Materials*, (2) *The Action of Cutting Tools*. By E. G. COKER, D.Sc., F.R.S., M.INST.C.E., M.R.I., Prof. of Engineering, University of London.

Thursdays, May 31, June 7: *The Nature of Enzyme Action*, by SIR WILLIAM M. BAYLISS, LL.D., D.Sc., F.R.S., Prof. of General Physiology, University College, London.

Saturdays, June 2, 9: 1, *The Vegetation of the Andes;* 2, *The New Zealand Flora*, by ARTHUR W. HILL, Sc.D., F.R.S., Director of the Royal Botanic Gardens, Kew.

CORRESPONDENCE

MAKING COLOUR MAKERS.

To the Editor of THE CHEMICAL NEWS.

SIR,—Professor Perkin, of Leeds University has just announced that no fewer than forty-seven students have gone out this year from the Departments of Colour Chemistry and Dyeing, of which he is the head, to take up positions with colour makers, wool dyers, cotton dyers, calico printers, artificial silk manufacturers, and

in other industries. It is heartening news to those who believe, as I do, that British industry depends to-day, and is in the future going to depend more and more, upon the pooling of scientific knowledge won at our universities and the technical ability which can be acquired only from large-scale production.

In these circumstances it is not quite clear on what Professor Perkin bases his fear that, even yet, the artificial dyestuffs industry might one day become "moribund" in this country. At the present moment both colour makers and colour users are practically unanimous in their determination that a national dyestuffs industry shall be maintained and developed in Great Britain; differences between them there are, but they are differences regarding *not the end to be attained, but the means* to attain it.

There has been a considerable amount of prejudice to be overcome in securing the widest use of British made dyes; but that is an inherent tendency which is gradually and successfully being lived down by British makers. Makers and users realise that they must work hand in hand, and it is an excellent augury for a continuance of amicable feeling that during the Ruhr crisis no attempt has been made to increase prices. Before the war we depended on Germany for eighty per cent. of our dyestuffs; to-day we can supply more than eighty per cent. of the dyes required by British colour users. It is a considerable achievement, and it gives promise in the future of offering many more than Professor Perkin's estimate of twenty openings a year to students qualified in colour chemistry.

I am, Yours, etc.,

W. J. U. Woolcock,

The Association of British Chemical Manufacturers, 166, Piccadilly, London, W.1.

27th April, 1923.

POTASSIUM PERMANGANATE APPLICATIONS TO EXCOECARIA AGALLOCHA.

Two bleach methods have been tried with evident success, both of which call for the co-operation of sulphurous acid as a decoloriser. The first method produced a wood almost of pure whiteness; the second showed a slight brownish tinge not altogether out of keeping with modern match manufacture.

The usage of neutral potassium permanganate constitutes the first process. The *gangwa* is chipped into sticks 4.5 cms. in length, having an approximate cross-sectional area of 4 sq. mm., and dropped into a solution of potassium permanganate (1:40). The chips immediately comence to decompose the solution and manganese dioxide is deposited upon them, as the following equation shows:—

$$2KMnO_4 = 2MnO_2 + K_2O_4.$$

The chips, after being allowed to blacken thoroughly, are removed, washed, and placed in a solution of sulphurous acid. The liberated hydrogen turned inwards and attacked the colouring matter contained in the wood, producing a superficial bleach.

Commercially, this method is quite workable for the adaption of a cheap and plentiful material, as the actual steepings do not last for more than three hours or so, although better results would be obtained by *spreading the two stages over a couple of* days. More rapid changes occur if the permanganate be slightly acidulated; this process is discussed *ut infra*.

The neutral-solution method is productive of an excellent whiteness, far superseding the grade of the average white pine so largely in use, while combustibility does not depreciate in the least. On the contrary, it is improved by the part-extraction of the aromatic substances contained therein, figures based upon calorific values having been obtained.

The estimate is based upon recent observations by Datta and Bosu, expanded by the present writer. The *gangwa* commenced to rot after 3 days, and repigmentation took place. Twenty-four hours is a convenient period.

In the case where the permanganate solution is acidulated with sulphuric acid, no beneficial results can be obtained. If, however, a mixture of sulphuric acid and potassium oxalate be used, satisfactory results are obtained. Hot-chamber drying should be replaced by centrifugal drying in this case, eliminating the tendency of the splints to char.

Here, only one stage is necessary, and the treatment can be performed in an hour. The bleach is not so good, and may be provocative of popular prejudice, but the process is cheap and in no way impairs combustibility. It is certainly a debatable point if the cheapness of the *gangwa* wood, plus cost of transport, plus cost of treatment, would compare with the prices paid for the best white pine; but if manufacturers contemplate the experiment, enormous supplies of the wood are available in tropical and sub-tropical localities.

J.M.

BOOKS RECEIVED.

Canada To-day, Edited by ROBERT J. ARNOTT. Pp. 204. 1923. The Canada Newspaper Co., Ltd., 110, St. Martin's Lane, W.C.2. 2s. 6d.

The Manufacture of Hydrochloric Acid and Saltcake, by ALEXANDER CHARLES CUMMING, O.B.E., D.Sc., F.I.C. Pp. XV. + 423. Vol. V. 1923. Messrs. Gurney & Jackson, 33, Paternoster Row, E.C.4. 31s. 6d. net.

Raw Materials for the Manufacture of Sulphuric Acid and the Manufacture of Sulphur Dioxide, by WILFRID WYLD. Pp. XIII. + 558. Vol. I. 1923. Messrs. Gurney & Jackson, 33, Paternoster Row, E.C.4. 36s. net.

PUBLICATIONS RECEIVED.

The British Association for the Advancement of Science has just issued as a reprint entitled *The Nitrogen Industry*, a report of the discussion in the Chemical Section of the British Association at the Hull meeting last year.

The discussion was opened by Dr. J. A. Harker, F.R.S., who gave an account of the post-war progress in the Fixation of Nitrogen in England and Abroad.

Mr. J. H. West contributed a paper entitled: *Raw Materials for Synthetic Ammonia: The Manufacture of Hydrogen and Nitrogen.*

Mr. C. J. Goodwin gave a paper on *The Häusser Process of Nitrogen Fixation*, and Dr. E. B. Maxted one entitled *Some Aspects of the Relation between Water Power and Nitrogen Fixation.*

The reprint, price 9d., is published by the Association at Burlington House, W.1.

The Department of Overseas Trade has just issued a report on the *Economic and Financial Conditions in Switzerland, Dec.*, 1922, by MR. E. C. D. RAWLINS, Commercial Secretary to H.M. Legation, Berne; pp. 77. Price 2s. 6d.

This report is a valuable resumé of the finance, legislation, trade industries, transport and social matters during the year.

New Patents.

THIS list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

9900—Elektrizitatswerk Lonza.—Process for preparation of urea salts from cyanamide. April 11.

10133—Franck, W.—Manufacture of sulphuric acid. April 13.

9779—Thermal Industrial & Chemical (T.I.C.) Research Co., Ltd.—Dehydration and distillation of tar or oils. April 10.

10003—Tyrer, D.—Manufacture of phenol and phenolic bodies. April 12.

Abstract Published this Week.

193722—Synthetic Tanning Agents.—Moeller, W., 20, Billhorner Canalstrasse, Hamburg, Germany.

Coal-tar oils of high boiling point or the hydrocarbons contained therein are subjected to treatment with finely divided sulphur, and the products sulphonated with ordinary or fuming sulphuric acid; the soluble sulphonated products are tanning agents, but may also be used for the same purposes as the non-sulphonated products, for example, as impregnating agents or lubricants. In an example, an anthracine oil of boiling point above 200° C. is heated with powdered sulphur at 100-150° C., and air blown through to remove sulphuretted hydrogen; sulphuric acid is then added and heating continued until the product is soluble in water; after dilution, neutralisation with alkalis, alkaline earths, or oxides or hydroxides of the light metals, the sulphates may be removed by filtration or crystallisation and the remaining solution used directly for tanning.

Messrs. Rayner & Co. will obtain printed copies of the published Specification, and forward on post free for the price of 1s. 6d. each.

PAMPHLETS.

Science by Definition Series.

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3291.

BRITISH EMPIRE EXHIBITION.

Science and Scientific Instruments.

Special efforts are being made by the British Empire Exhibition authorities to have all branches of science adequately represented at Wembley next year, not only in the organised exhibits, but by means of conferences and discussions on scientific subjects. The main objects of the Exhibition are to demonstrate the great resources of the British Empire in raw materials and the capacity and skill of our manufacturers in producing the highest class of goods in every branch of industry. The Exhibition will also show the high position we have attained in music, literature, painting and the arts. Husbandry, the cultivation of gardens, and all the amenities of life will be illustrated. There will be lectures, conferences and cinemas dealing with all phases of our national life.

An impression got abroad at one time that the Exhibition would be visited mainly by millions of people interested in sport and amusements. It is important that this impression should be corrected, and that the public should realise that the outstanding feature of the Exhibition will be its educational purpose in relation to science, art, commerce and industry. Scientific instruments, for instance, will form a notable feature of the Exhibition. It is hoped to include representative surgical, optical, meteorological and photographic appliances.

The latest inventions and the most up-to-date tools of the workshops of science will be brought, by means of this Exhibition, to the notice of a wider public, and new opportunities will be created for the development of trade in those industries.

THE DECOMPOSITION OF THE AMINOBENZOIC ACIDS BY BOILING WATER.

By L. McMaster and R. L. Shriner.

(Contribution from the Chemical Laboratory of Washington University.)

The decomposition of anthranilic acid, when heated above its melting point, into carbon dioxide and analine is well known. Fritzsche[1] identified the gas evolved as carbon dioxide, and Liebig[2] showed that the oily distillate obtained was aniline. Powlewski[3] studied this decomposition and found it to be complete when the acid was heated for 1 hour at 205-210°.

The *m*-aminobenzoic acid yields carbon dioxide, aniline and ammonia on treatment with caustic potash[4], and the *p*-aminobenzoic acid gives aniline and carbon dioxide when treated with conc. hydrochloric acid.[5] However, no mention is made of the effect of heating aqueous solutions of these acids.

The object of this investigation was to study not only the decomposition of the aminobenzoic acids by boiling water but also to determine the rate of decomposition and the volatility of the acids with steam.

Experimental Part.

Products of Decomposition. — The presence or absence of aniline and carbon dioxide as products of the decomposition was ascertained by boiling 5g. samples of the pure acids[6] with water under a short reflux condenser for 3 hours, the gases evolved being led into a tube of lime-water protected by a tube of soda lime. The solutions were then neutralised with sodium hydroxide, extracted with ether, and the ether extracts tested for aniline. It was found that the *ortho* and *para* acids gave aniline and carbon dioxide while the *meta* acid did not.

Rate of Decomposition. — Weighed samples of the acids were placed in Erlenmeyer flasks and distilled water was added. The flasks were heated just to boiling over the Bunsen flame, and then transferred to an electric hot plate, where gentle boiling was maintained for the desired length of time. During this period the carbon dioxide and aniline escaped from the flasks along with the steam. The quantity of solution was kept constant by the frequent addition of hot water during the boiling period. The flasks were then removed from the hot plate and the undecomposed acid deter-

[1] *Fritzsche, Ann.*, 1841, XXXIX., 86.
[2] *Liebig, ibid.*, 1941, XXXIX., 94.
[3] *Powlewski, Ber.*, 1904, XXXVII., 592.
[4] *Beilstein.* "*Handbuch der Organischen Chemie,*" *Voss*, 1896, II., 1,256.
[5] *Weith, Ber.*, 1879, I., 105.
[6] *We wish to thank the Monsanto Chemical Works of St. Louis for the anthranilic acid which was prepared and purified by them for us.*

mined by titration with standard sodium hydroxide, using phenolphthalein as indicator. The amount of acid decomposed was obtained by subtracting this value from the weight of the sample. Since the amount obtained by this method would also include the acid volatilised with the steam, a correction was made in order to obtain the true decomposition. The average rate of evaporation of water from the flasks was found to be 100 cc. per hour; so for each hour of boiling the amount of acid per 100 cc. of water, as determined by the distillation with steam, was subtracted from the total weight of the acid lost.

The steam distillations were carried out in the usual manner using a Claisen flask. The weight of the acid per 100 cc. of distillate was determined by titration with standard alkali. It was found that 100 cc. of the distillate contained 0.016 g. of the *ortho* acid and 0.0056 g. of the *para* acid. The *meta* acid is not volatile with steam.

The following data were obtained:—

TABLE I.
Anthranilic Acid.

	2 g. in 150 cc. water				3 g. in 200 cc. water			
Boiling time Hours	Acid decomp. G.	Acid decomp. Apparent %	True %	K	Acid decomp. G.	Acid decomp. Apparent %	True %	K
1	0.0672	3.36	2.56	0.027	0.0921	3.07	2.54	0.028
2	0.1429	7.15	5.55	0.029	0.1857	6.19	5.13	0.028
3	0.1870	9.35	6.95	0.025	0.3132	10.44	8.84	0.031
4	0.3072	15.36	11.66	0.031	0.4446	14.82	12.69	0.033
5	0.3422	17.11	13.11	0.027	0.5592	18.64	15.97	0.033
6	0.3768	18.84	14.04	0.025	0.6006	20.02	16.82	0.030
7	0.4052	20.26	15.46	0.025	0.6948	23.16	19.43	0.028

TABLE II.
Para-Aminobenzoic Acid.
2 g. in 200 cc. water.

Boiling time Hours	Acid decomp. G.	Acid decomp. Apparent %	True %	K
1	0.0370	1.85	1.57	0.015
2	0.0640	3.20	2.64	0.014
3	0.0852	4.26	3.52	0.013
4	0.1326	6.63	5.51	0.014
5	0.1754	8.77	7.37	0.015
6	0.2025	10.13	9.55	0.017

DISCUSSION.

By substituting the decomposition values in the expression for a unimolecular reaction, $K = \frac{1}{0.4343\,t} \log \frac{a}{a-x}$, where a is the initial concentration, x the amount of acid decomposed, and t the time in hours, the values for the velocity constants were obtained.

In the case of anthranilic acid the values of K for the initial concentration of 3 g. are greater than in the case of the 2g. sample, apparently indicating an increase in decomposition with increasing size of sample. However, the increase is comparatively small and is due partly to the fact that the correction for volatility with steam and the error due to mechanical losses during boilnig form a smaller percentage of the acid in the case of the 3g. sample than in the case of the 2g. sample.

It is interesting to note that only the *o*- and *p*-aminobenzoic acids decompose into aniline and carbon dioxide and that the *para* acid decomposes only half as fast as does the *ortho*. A possible explanation of these facts may be due to the formation of the inner salt and the subsequent decomposition of this salt.

The *para* acid also forms this inner salt but to a much less extent than anthranilic acid, while the *m*-aminobenzoic acid does not form such a salt at all, and hence does not give aniline and carbon dioxide.

SUMMARY.

1. The anthranilic acid and *p*-aminobenzoic acid are decomposed by boiling water into aniline and carbon dioxide, but the *m*-aminobenzoic acid is not.

2. Both anthranilic acid and *p*-aminobenzoic acid are slightly volatile with steam, while *m*-aminobenzoic acid is not.

3. The rate of these decompositions has been studied and the reaction found to be monomolecular. The *para* acid decomposes half as fast as does the *ortho*.

St. Louis, Missouri.

[*Reprinted from the Journal of the American Chemical Society, Vol. XLV., No. 3. March,*

ARRESTING DECAY IN BUILDING STONES.

The question of the deterioration of stonework in buildings is a matter of general economic importance. But in the cases of *our historic buildings and ancient monuments* prevention of the serious decay and gradual demolition of tooled surfaces and main structures constitutes a special problem which has engaged attention of many investigators for a considerable time without, however, finding any generally satisfactory solution.

The investigation involved is very complex, and needs to be approached from different angles with the help of wide scientific knowledge.

Accordingly, it has been decided to set up under the Department of Scientific and Industrial Research a special committee of the Building Research Board to report on the best methods by which decay in building stones, especially in ancient structures, may be prevented or arrested.

The Chairman of the Committee will be Sir Aston Webb, K.C.V.O., P.R.A., and the other members will be :—Mr. R. J. Allison, C.B.E., F.R.I.B.A., Professor C. H. Desch, F.R.S., Mr. A. W. Heasman, O.B.E., Mr. J. A. Howe, O.B.E., Sir Herbert Jackson, K.B.E., F.R.S., Dr. Alexander Scott, F.R.S., and Mr. H. O. Weller, M.I.C.E., Hon. A.R.I.B.A.

All communications should be addressed to the Secretary, Department of Scientific and Industrial Research, 16, Old Queen Street, S.W.1.

IS THERE AN ELEMENT OF ZERO ATOMIC NUMBER?

By F. H. Loring.

The subject of atomic numbers is of great interest, and the existence of an element, if it may be so called, of zero number may be considered in this connection. To discuss this possibility one must have some basis for the argument.

The following scheme, in the writer's opinion, is suggestive, and while the figured values follow in general of necessity when using Rydberg's numbers, it shows that an *initial* element of zero atomic number could be introduced so as to give a series 0, 1, 2, 3, 4, 5, as shown, completed to its origin.

Scheme.

Act. Elmts. preceding		At. No.	
He = 2		He = 2.	2 - 2 = 0.
Ne = 2 + 7 = 9.		Ne = 10.	10 - 9 = 1.
Ar = 9 + 7 = 16.		Ar = 18.	18 - 16 = 2.
Kr = 16 + 17 = 33.		Kr = 36.	36 - 33 = 3.
Xe = 33 + 17 = 50.		Xe = 54.	54 - 50 = 4.
Rn* = 50 + 31 = 81.		Rn* = 86.	86 - 81 = 5.

Abbreviations: Act = active. Elmts = elements. At. No. = atomic number.
* also Tn and An (Emanations) which occupy the same atomic-number place.

The term *element* represents some places or lacunæ which may never be properly filled; but this observation does not apply to the elements below scandium according to the writer's studies (this Journal, Vol. CXXV., Nov. 24, 1922, p. 309).

Considering, therefore, the existence of an element preceding hydrogen, it would find a place in many periodic schemes; for example, the one devised by the writer (Wedge type) and published in this Journal, Vol. CXXV., p. 386. In this case the series 2, 6, 10, 14 will be completed to its origin by introducing this hypothetical member.

In Bohr's recently published book, *Theory of Spectra and Atomic Constitution*, page 70, a pyramid type of periodic table is shown which appears to be a development of one due to T. Bayley (1882), reproduced in Mellor's *Inorganic Chemistry*, page 810. Bohr

says: "Compared with usual representations of the periodic system, this method, proposed more than twenty years ago by Julius Thomsen, of indicating the periodic variations in the properties of the elements, is more suited for comparison with theories of atomic constitution." In this type of tabb the element in question could stand at the apex of the pyramid. Whether the table is a "wedge" or a "pyramid" seems to make no difference, but in the former type a numerical rule may be used as an argument in favour of an element preceding hydrogen, that is to say the displacements occasioned by the wedge arrangement lends itself to this treatment. It may be mentioned in this connection, that the object of the Wedge scheme was to correlate the chemical properties of the elements whilst giving the expansions obtained in the pyramid type of table, particularly on account of the rare-earth elements.

Now a certain peculiarity arises from the introduction of a new member at the beginning of the series. In the writer's table (*loc. cit.*, p. 387) this element would fall into the zero group, yet it could not be inactive according to the above rule. Furthermore, an element before hydrogen of atomic weight 1.008 would presumably have to be a fraction. One must proceed cautiously in advancing new ideas, and it can probably be shown that there are just as many arguments for as against the existence of such an element; and, therefore, no probable decision can be arrived at. The subject is, however, a very interesting one, and some further views will be given.

Notes.

The above expression, "Rydberg numbers," refers to the atomic numbers of the inert gases which may be calculated by the well known equation due to Rydberg. The expression, "pyramid table," is not to be taken in the solid-figure sense. It merely means that the table, as drawn, is suggestive of a pyramid, but perhaps a better name could be found. It is convenient to have names for the purpose of identification though they may not be scrupulously accurate when applied to more or less elastic schemes such as periodic tables.

London, S.W.4.
May 12, 1923.

PRESERVATION AND USE OF ARTICLES MADE OF RUBBER.

By A. Pfestorf.

When not in actual use, rubber goods should be well wrapped in paper to hinder the access of air and light. They should be kept in a cool place, preferably at a temperature of 10-12° C. Sunlight has a deleterious effect on rubber.

In order to attach rubber tubing to glass or metal, it is usual to damp the inside of the rubber with water or glycerine. Both these methods possess disadvantages, since, in time, the rubber adheres so firmly to the glass or metal, and can only be removed by cutting. This difficulty is overcome if a paste made of a mixture of glycerine with one-third of its weight of talc is used. In this case, when the glycerine is absorbed the talc remains and continues to function as a lubricant.

The exterior diameter of the glass or metal tube should not be much larger than the interior diameter of the rubber.

When used with a metal clip, only rubber tubing of good quality should be used, since this is less likely to adhere by its inner walls when these are pressed in contact for some time. The walls of such rubber should also be thick, so that it may remain supple for a considerable time.—(*From Chemiker Zeitung*, 1923, XLVII., 72.)

BRITISH INDUSTRY AND THE EUROPEAN SITUATION.

Sir Eric Geddes delivered a speech on the industrial situation at the seventy-fifth annual meeting of the Association of Trade Protection Societies of the United Kingdom, at the Hotel Cecil, on Thursday, May 10.

Sir Eric reviewed the position of British industry at the present time, and stressed the difficulties of providing work for the large body of unemployed in the face of the collapse of the European markets.

Special emphasis was laid upon the very adverse effects on U.K. trade by the continued occupation of the Ruhr.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, MAY 10.

Papers read:—

A. FOWLER, F.R.S. *The Series Spectrum of Trebly-ionised Silicon (Si IV).*

Numerous new lines of silicon have been observed and have been classified in four groups, in extension of the groupings made by Lockyer in connection with stellar spectra. The four groups represent successive stages of ionisation, and have been designated Si I, Si II, Si III, and Si IV. The spectra consist alternately of triplets and doublets, and the series constant has successive values N, 4N, 9N, and 16N.

The present paper deals with the series of Si IV, for which the new data have fully established 16N as the stries constant. The spectrum is similar to that of neutral sodium, Na I, but the main series which correspond with the familiar series of Na I are in the extreme ultra-violet, while the second series, which partially fall within the ordinary range of observation, correspond with series which occur in the infra-red in Na I.

Including Paschen's recent work on Al III, and the author's previous work on Mg II, which also have spectra similar to that of Na I, data are thus available for the comparison of the spectra given by four similarly constituted atoms, which differ mainly in the charge of the nucleus. The doublet separations and the series terms show greater regularity than those for elements of the same chemical group.

The highest limit of the Si IV system is 364,117, corresponding to an ionisation potential of 40.6 volts.

SIR R. ROBERTSON, F.R.S., and W. E. GARNER. *Calorimetry of High Explosives.*

The object of this investigation was to determine the quantities of heat and volume of gases produced when high explosives are detonated under standard conditions of confinement and compression, in order to obtain a measure of energy developed, and to investigate nature and reactions of gases evolved.

A calorimetric bomb was devised in which high explosives could be brought to true detonation under comparable conditions as regards density of loading and confinement, without using a large quantity of explosive. The methods of initiating detonation of the explosive, of determining its heat value, and of measuring gases evolved, are described.

Results are given for some high explosives; and in the case of an explosive balanced in respect to total combustion, where it is possible to calculate values for heat of detonation and volume of gases, the results are shown to be in agreement with these.

The influence of the higher heat of formation of phenol with respect to toluene is shown to be reflected in the similar values for heat of detonation of trinitrophenol and of trinitrotoluene, although the latter has much less oxygen for its combustion.

The paper discusses causes which influence the nature of the products, and the effect of conditions under which detonation is carried out on heat generated, and gaseous reactions involved, chiefly with regard to liberated carbon. The results afforded by imperfect detonation are also quoted.

H. S. HELE-SHAW, F.R.S. *Stream-Line Filter.*

The author points out that in recent experiments he had found very thin films of coloured liquid, or liquid containing matter in very fine suspension, either lose their colour in the one case, or become deprived of their suspended matter in the other, on entering such thin films.

The paper describes a new form of filter, in which sheets of paper made impervious to the fluid containing the suspended matter are arranged in a pack. By perforating the pack with a large number of holes it is possible to get the equivalent of a number of sources and sinks. This was obtained by using high pressures, so as to force the matter from one row of holes, acting as sources between the interstices of the paper, to another row of holes, each hole in the latter acting as a sink.

The use of such a filter enables what would otherwise be a very slow rate of filtration to be made sufficiently rapid for actual use, and the paper gives a description of a laboratory filter constructed on this principle, in which the colouring matter of various dyes, from what were apparently complete solutions, has been removed, while substances like peat water have been rendered clear and colourless.

F. W. Aston, F.R.S. *A Critical Search for a Heavier Constituent of the Atmosphere by means of the Mass-spectrograph.*

A critical search for a gaseous inert element, heavier than xenon, is described, in which the residues absorbed in charcoal from over 400 tons of air are dealt with.

The final analysis is made by means of the mass-spectrograph. The result is negative and indicates that such an element certainly does not exist to the extent of 1 part in 10^{15} of air, and probably not to the extent of 1 part in 2×10^{16} parts of air by volume.

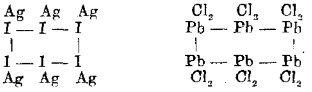
Faint bands observed in the region corresponding to masses 150 and 260 are described and their origin discussed. The first of these is shown to be due to a complex molecule of mercury with a multiple charge, but no conclusion is reached in the case of the other.

The results of the experiments are not in accordance with the presence of molecular *krypton and xenon in the air, recently* suggested.

Papers read in title only:—

H. E. Armstrong, F.R.S. *Electrolytic Conduction: Sequel to an Attempt* (1886) *to Apply a Theory of Residual Affinity.*

Referring to the distinction which he drew in 1886 between simple and composite electrolytes—the former being electrolytes *per se*, the latter solutions of "salts"—the author calls attention to the diverse behaviour of the silver and lead haloids on electrolysis; the current being carried, as it were, by the metallic ion of the silver and by the halogen of the lead compound. The conclusion is drawn that the salts of the two metals differ in structure—perhaps thus



The assumption is made that the primarily active unit is the fundamental molecule, and that the circuit is formed by these molecules being coupled with the electrode face and with the complex molecules.

A similar interpretation is applied to aqueous solutions.

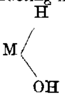
H. E. Armstrong, F.R.S. ***The Origin of Osmotic Effects. IV.—Hydrono-dynamic Change in Aqueous Solutions.***

The conclusions arrived at are summarised in the following propositions:—

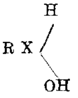
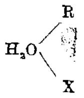
1. "Water" *is a complex saturated with* the gas *Hydrone*, OH_2. Primarily hydrone is the sole potentially "active" constituent, but *it becomes actually active only* under conditions which suffice to determine electrolytic change.

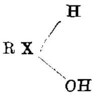
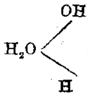
2. The vapour pressure of water, or of a solution, is the measure of the proportion of free hydrone molecules present in the liquid.

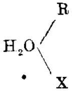
3. Although the vapour pressure is lowered in presence of any solute, the solution acquires attractive properties. The internal activity is increased whilst external activity is diminished.

4. The effect produced may be ascribed to an interaction of molecules of the solute and those of hydrone. From non-electrolytes (under the influence of conducting impurity) a simple hydrol is formed , only a single molecule of hydrone being "distributed" upon the molecule of the solute, whatever its magnitude.

5. In the case of potential electrolytes, a reciprocal interchange of radicles of salt and hydrone is to be postulated. Not only *is the solute hydrolated, but it is distributed* upon hydrone, the salt X′R′ giving rise initially to the reciprocal systems

 and 

6. As the concentration is lowered, under the influence of hydrone, the complex  is more and more converted into *hydronol*, . Ultimately

the solution contains the solute only in the form  together with an equal number of molecules of hydronol.

7. The "distributed" reciprocal complexes, including hydronol, are the electrochemical agents in a solution. The negative radicle in such complexes has greater residual affinity than it has in the original simple molecules.

8. The osmotic pressure manifest in an aqueous solution is the pressure exercised by molecules of hydrone acting as though they were present in the gaseous state. In short, osmotic pressure developed within an aqueous solution, whatever the solute, has origin in one and the same cause, and is properly spoken of as *hydrono-dynamic*—if the word be permissible: indeed, this term may be used as expressive of the general *activity of water, electro-chemical and osmotic.*

R. W. Wood, For. Mem. R.S., and A. Ellett. *On the Influence of Magnetic Fields on the Polarisation of Resonance Radiation.*

It is shown that in the case of the resonance radiation of mercury and sodium vapour strong polarisation of the light can be produced by weak magnetic fields properly orientated, and the polarisation of the light normally present can be destroyed by a magnetic field in a certain orientation. The field strength necessary for the destruction of the mercury vapour polarisation is less than one Gauss.

W. G. Palmer. *A Study of the Oxidation of Copper and the Reduction of Copper Oxide by a New Method.* Communicated hy Sir William Pope, F.R.S.

A film of copper about 1/1000 mm. thick is prepared by chemical means on a china-clay rod, which is then clamped in a circuit carrying a small current at constant E.M.F. The film is oxidised at temperatures 130°-210° C. with gaseous oxygen at various pressures up to 1 atmosphere, and the rate of oxidation determined by measurements of the resistance of the film.

The rate of oxidation is proportional to the second power of the amount of metal in the film, and, for pressures up to 300 mm., to the square root of the oxygen pressure. Between 170° and 190° C. the temperature-coefficient of the oxidation appears to be negative owing to the simultaneous oxidation of cuprous oxide first formed, some oxygen in the adsorbed film being thus deviated from the metal.

When hydrogen or carbon monoxide is mixed with the oxygen the rate of oxidation is greatly enhanced after a short initial period, during which the rate of oxidation is only slightly less than with oxygen alone. The rate of reduction of copper oxide by hydrogen and by carbon monoxide was studied by similar means. Both gases are adsorbed on the metal present and reduce adjacent oxide, but with hydrogen the water formed also adheres to the metal.

The rate of reduction in both cases is directly proportional to the amount of metal present, an additional term in the case of hydrogen representing the action of the water.

E. A. Fisher. *Some Moisture Relations of Colloids. II.—Further Observations on the Evaporation of Water from Clay and Wool.* Communicated by Prof. A. Smithells, F.R.S.

The study of the evaporation of water from certain colloid materials described in a former paper has been extended to some other materials, notably to kaolin and a ball clay.

The curvature occurring in the evaporation curves of clay soils, which was formerly attributed to shrinkage, is not found in the curves obtained with ball clay, although this substance also shrinks on drying. The particular type of curvature appears to be found only in the evaporation curves of such materials as soils, which are mixtures of colloidal and non-colloidal substances, and is due to the simultaneous evaporation of imbibitional water held by the colloid and of interstitial water held as water-wedges between the soil grains. The former water evaporates at a practically constant rate, while the latter evaporates at a rapidly diminishing rate, curvature in the evaporation curve resulting.

The bearing of these results on the evaporation of water from wool fabrics is discussed, and it is concluded that the linear rate-curve of wool is not inconsistent with a real shrinkage occurring, although so far such a shrinkage has not been demonstrated.

The work is being continued.

THURSDAY, MAY 17.

Papers read :—

A. E. H. TUTTON, F.R.S. (1) *A Universal Interferometer.* (2) *A Wave-length Torsometer and its Use with the Universal Interferometer.*

PROF. L. N. G. FILON, F.R.S., and F. C. HARRIS. *On the Diphasic Nature of Glass as shown by Photo-elastic Observations.*

PROF. C. E. INGLIS. *Stress Distribution in a Rectangular Plate having two Opposing Edges sheared in opposite Directions.* Communicated by Prof. E. G. Coker, F.R.S.

Papers read in title only :—

PROF. T. H. HAVELOCK, F.R.S. *Studies in Wave Resistance—Influence of the Form of the Water-plane Section of the Ship.*

W. M. H. GREAVES. *On a certain Family of Periodic Solutions of Differential Equations, with an application to the Triode Oscillator.* Communicated by Prof. H. F. Baker, F.R.S.

ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on May 18, at 9 o'clock, will be delivered by WILLIAM MORRIS MORDEY, Past Pres. I.E.E., M.-Inst.C.E., M.R.I. The subject is *Recent Studies in Alternating Magnetism* (with experiments).

On Tuesday, May 15, PROF. A. C. SEWARD, Sc.D., F.R.S., gave a lecture on *Arctic Vegetation of Past Ages.*

On Thursday, May 17, PROF. E. G. COKER, D.Sc., F.R.S., M.R.I., delivered a paper on *Engineering Problems solved by Photo-elastic Methods.*

The General Monthly Meeting of the members of the Royal Institution was held on May 7, the Duke of Northumberland, President, in the chair.

Sir J. J. Thomson was elected Honorary Professor of Natural Philosophy, and Sir Ernest Rutherford Professor of Natural Philosophy.

It was announced that the Duke of Northumberland, President, had nominated the following gentlemen as Vice-Presidents for the ensuing year: Dr. Mitchell Bruce, Lord Iveagh, Sir Edward Pollock, Lord Rothschild, Sir Alfred Yarrow, the Rt. Hon. Lord Justice Younger, Sir James Crichton-Browne, treasurer, and Sir Arthur Keith, secretary.

Dr. P. J. Le Riche and Dr. Liebert were elected members.

THE CHEMICAL SOCIETY.

An informal meeting was held on Thursday, May 17, 1923, after the conclusion of the formal business of the Ordinary Scientific Meeting.

ROYAL SOCIETY OF ARTS.

On Monday, May 14, the third Howard lecture, entitled *The Development of the Steam Turbine,* was delivered by STANLEY S. COOK, B.A. (CANTAB.), M.I.N.A., M.I.M. (of Parsons Marine Steam Turbine Co.).

On Wednesday, May 16, at the Ordinary Meeting, MR. LEON GASTER, F.J.I., Editor of *The Illuminating Engineer,* read a paper entitled *Industrial Lighting and the Prevention of Accidents.* Sir Malcolm Delevingne, K.C.B., Assistant Under-Secretary of State, Home Office, presided.

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society was held in the Physical Chemistry Theatre, University College, Gower Street, London, W.C.1, on Wednesday, May 16.

The following papers were received and discussed :—

On the Refractive Index Changes in Optical Glass occasioned by Chilling and Tempering, by F. TWYMAN, F.INST.P., and F. SIMEON, B.Sc., F.INST.P.

Notes on Burettes, by VERNEY STOTT, B.A., F.INST.P.

A New Method of Glass Melting, by A. FERGUSON.

The Drying out and Warming Up of Tank Furnaces, by C. SAXTON, A.M.I.E.E.

Notes on the Design of Pot Arches, by TH. TEISEN, B.Sc., C.E.

WORKS VISIT.

By the courtesy of the Directors, a visit was arranged on the morning of Thursday, May 17, to the new works of Messrs. James Powell & Sons (Whitefriars), Ltd., Wealdstone, Harrow.

THE OPTICAL SOCIETY.

A meeting was held at the Imperial College, Imperial Institute Road, South Kensington, on Thursday, May 10, when a paper on *Stereoscopy Re-stated*, by DR. J. W. FRENCH, F.INST.P., was read and discussed.

THE FARADAY SOCIETY.

Papers read on May 14:—

Some Notes on the Etching Properties of the α and β Forms of Tri-carbide of Iron, by FRANK CHARLES THOMPSON, D.MET., B.SC., and EDWIN WHITEHEAD.

In the course of some work on the etching properties of the carbides in alloy steels it was noticed that a dilute solution of ammonium oxalate, which according to Matwieff stains cementite red, did not produce this effect. In a tungsten steel one of the constituents of which was a carbide which had shown the etching characteristics of cementite, it was found that with the Matwieff reagent a deep reddish coloration was produced.

It was believed that a small amount of tungsten in the carbide might cause the retention of that form which is normally stable only above 200° C. The change commences at 160° C., and is complete about 200° C. At even lower temperatures than 160° there may be some modification of cementite. Further, if a white cast iron, or a high carbon steel is quenched at 280° C. so that the high temperature, or β form, of carbide is retained down to normal temperatures, the electrical resistance undergoes a gradual fall. This means that the cementite in the β form is tempered at room temperatures and slowly reverts to the α state.

The instability of β cementite has rendered it difficult to obtain sharp differences in etching properties. Further, the differences which are fairly clearly shown immediately after the quenching soon cease and indistinct structures are obtained.

The heatings were effected in an oil bath, and duplicate specimens were quenched from 270° C., and slowly cooled in the oil respectively. In the case of the Swedish white iron a third sample was cooled from 190° C., a temperature at which some, but not all, of the changes have occurred. At each temperature the samples were allowed to remain for a period of one hour before they were cooled.

It is of interest that the authors have been unable to obtain a suitable etching with ammonium oxalate of cementite *in either form*. At times a very faint pink coloration was observed, which was insufficiently pronounced to be of value.

It is also remarkable that despite the well-known fact that a hot solution of alkaline sodium picrate will darken carbide of iron, neither the sodium picrate nor the caustic soda will effect this by themselves.

The reagents which darkened cementite are:—

(1) Alkaline sodium picrate;

(2) Alkaline sodium benzoate, 6.3 grams benzoic anhydride, 20 grams caustic soda, and 100 cc. water, used hot for 30 minutes.

(3) Alkaline potassium ferricyanide, Murakami's reagent—4 minutes at 100° C.

(4) Le Chatelier's reagent, *viz.*, a boiling solution of 10 per cent. lead nitrate with an equal volume of 50 per cent. caustic soda, etches in 5 minutes.

(5) A boiling solution of alkaline copper potassium cyanide.

(6) A 10 per cent. solution in water of ammonium molybdate. Etches the carbide in the cold in 18 hours.

(7) An alkaline solution of ammonium molybdate aided by a small electric current. Etches cementite in a few minutes.

No acid solution will darken cementite, and, with the exception of the ammonium molybdate solution, and that very slowly, no neutral solution was discovered which will do this. None of the reagents possess any marked advantage over the standard alkaline sodium picrate, though some act a little more quickly. Murakami's reagent, aided by a small electric current, is quite useful and possesses potentialities as a means of differentiating between the two forms of carbide.

An Example of Polymorphism in an Inter-Metallic Compound, by DAVID STOCKDALE, B.A.

The author has recently determined the liquidus of the copper rich aluminium-copper alloys, using sensitive apparatus for measuring temperatures.

Between 9 and 18 per cent. by weight of aluminium, this liquidus is a smooth curve which is described in a remarkable manner by the equation—

$$T = -x^2 + 25x + 891,$$

where T is temperature in degrees Centi-

grade, and x is the percentage of aluminium by weight, the origin being ($T = 0°$ C., $x = 0$ per cent. aluminium).

Between 18 and 22 per cent. the equation—

$$T = -2.8x^2 + 97.4x + 169$$

agrees closely with observed values.

A compound having the formula Cu_2Al would contain 17.6 per cent. of aluminium. The two equations which describe the experimental results so well would show that the compound Cu_2Al does exist, but that it is unstable above 1,015° C.

If the compound is formed at 1,015° C. it is to be expected that cooling-curves of alloys between, say, 16 per cent. and 18 per cent., would show thermal arrest points at that temperature, due to the heat of formation of the compound Cu_2Al. Experimentally, this is found to be the case, though, as the evolution of heat is small, the temperatures are difficult to measure with accuracy. The 16.5 per cent. alloy shows a point at 1,015° C., the 17 per cent. at 1,016° C., and the 17.5 per cent. at 1,017° C. The 18 per cent. also probably shows an evolution of heat, but it is merged in the large quantity of heat evolved as the alloy first freezes.

Further evidence for the existence of Cu_2Al lies in the fact that the nearer the composition approximates to 17.6 per cent. of aluminium the harder is the alloy to etch. A body of the above composition is extremely resistant to acids.

The Elasticity of Organogels of Cellulose Acetate, by Ernest Walter John Mardles, M.Sc. (Lond.), F.I.C.

The determination of the elasticity of a gel is complicated by the persistence of strain after removal of stress, so that the elasticity is perfect only for small stresses applied for a short time. The phenomenon of plastic strain has been studied with different materials, and the general conclusions are applicable to the elastic properties of jellies. Various workers have distinguished between (*a*) the instantaneous elastic deformation which disappears simultaneously with the suppression of the stress (primary or elastic strain), (*b*) the reversible deformation which is a function of time (secondary strain, subpermanent deformation, or reactivity), and (*c*) viscous or plastic flow, which is irreversible with time and produced at constant rate.

Hatschek observed that optical anistrophy, caused by straining prisms of gelatine gel (10 per cent.), did not disappear with the removal of stress. The experiments, repeated with gels of cellulose acetate in benzyl alcohol, gave similar results, the period of observation extending over several weeks.

The materials used were the same as those employed for the other experiments on the reversible sol-gel transition. Young's modulus was measured by observing the extension of rods or strips on loading, by means of a travelling microscope. The specimens were contained in a constant temperature and humidity chamber, whilst under examination, since the modulus is considerably affected by temperature changes, also by humidity changes on account of the hygroscopic nature of the cellulose derivative. The relative modulus of rigidity of the organogels was determined by a method similar to that used by Rankine, *viz.*, allowing about 100 grams of the sol to set between two coaxial cylinders, the diameter of the outer being 4.5 cm. whilst the diameter of the inner was varied at will, according to the degree of rigidity of the gel under examination. The outer cylinder was fixed and a known weight acting over a light pulley tended to rotate the inner. The angles of twist produced by small loads were observed by means of a scale fixed at a distance of about 50 cm., a small correction being applied for the friction of the pulley.

The relation between the modulus of elasticity and concentration for the organogels of cellulose acetate is not expressed by any simple formula. The expression $E = kC^n$ represents the relation approximately at higher concentrations over limited ranges. The value of n decreases with fall in temperature. The relation between log E and temperature is approximately rectilinear over the range of temperature examined. The physical significance of these relations is discussed.

Addition of substances to the gel mainly affects the modulus in proportion to the change in the number of particles which aggregate.

The changes, with time, in the modulus of rigidity of the gels, associated with the reversible sol to gel transition, have been studied. The significance of the shape of the curves relating elasticity and time, has been discussed.

The Vapour Pressures of Concentrated Cane Sugar Solutions, by Edgar Philip Perman and Horace Leonard Saunders.

Many measurements have been made of the vapour pressures of dilute solutions, but

comparatively little has been done on those of higher concentrations except at low temperatures.

The experiments in this investigation have been confined to cane sugar, and observations have been made with concentrations from 10 per cent. to saturation; in a few cases it has been possible to use a solution which was supersaturated. The measurement of the vapour pressure is a direct one, the actual pressure of the vapour being balanced against a column of mercury. It was found that Babo's Law held for sugar solutions.

Some Experiments on the Hardness and Spontaneous Annealing of Lead, by A. L. NORBURY, M.Sc.

Part I.—Description of an adaptation used for making Low Load Brinell Impressions with a Lever Tensile Machine.

Part II.—Brinell Hardness Tests on Lead using various Loads maintained or Various Lengths of time. Results interpreted according to Meyer's Formula: $L = ad^n$

Part III.—Effect of Cold-Hammering on the Hardness of Lead. Results showing (*a*) Increase in Hardness, and (*b*) Spontaneous Annealing.

I.—Brinell hardness tests on lead showed that the time during which the load was maintained was an important variable. Differences of seconds had appreciable effects on the diameters of the Brinell impressions produced. To make tests on lead it was necessary to use a machine in which the load could be applied and removed almost instantaneously. Moreover, owing to the fact that lead is such a soft metal, only loads up to about 300 kg. can be used with a 10 mm. ball.

The lever tensile machine used was an adapted 10 ton Buckton, and it fulfilled the requirements.

II.—The specimens of lead tested were cut from an ingot of Cookson's chemically pure lead (99.99 per cent. Pb.).

The surfaces on which the Brinell tests were made were filed and emery papered down to O emery, and were then annealed at 100° for 1 hour to remove any surface hardening effects.

The time of maintaining the load is a very important variable which must be accurately determined when measuring the Brinell hardness of lead. It is also obviously necessary to make each impression on a fresh surface—as distinct from the method of making concentric impressions which is permissible in the case of harder metals.

III.—The time taken to reduce a lead specimen to a given thickness varied between about 1 and 8 seconds. The specimen was then rapidly transferred to the testing machine, and the first Brinell impression made 20 seconds after completion of hammering. Further impressions were made at intervals. It was difficult to control the conditions of hammering very exactly and there are certain obvious variables.

Lead is hardened by cold-work, and it was shown that, within certain limits, the greater the amount of cold-work the greater the hardening. It is spontaneously annealed at room temperature (16° to 18°). The rate of annealing increases with the amount of deformation, and this introduces an interesting result in that lead which has been very severely hammered shows no increase in hardness. The severe deformation in this latter case has caused such rapid annealing that the lead is dead soft 20 seconds after hammering.

THE GEOLOGICAL SOCIETY.

At the meeting on May 2, Prof. A. C. Seward, Sc.D., F.R.S., President, in the chair, PROF. JOHN JOLY, D.Sc., F.R.S., delivered a lecture on *The Bearing of some Recent Advances in Physical Science on Geology*.

After referring to the discovery by the present Lord Rayleigh of the general distribution of radioactive materials and to the earlier but more recently developed discovery of isostasy, the lecturer observed that, assuming that the dense layer upon which, according to the theory of isostasy, the continents float, is composed of basalt possessing the average radioactivity of basalts, it may be calculated that if this substratum is now solid (as appears from both tidal and seismological evidence), it will have acquired sufficient radioactive heat to become fluid in about 30 million years.

The change of density then occurring will cause a downward motion of the continents relative to the ocean, and transgressional seas will result. After a long period, during which the liquid magma (under tidal forces) circulates from beneath the continents (which, owing to their own radioactivity, act as an adiatherminous covering) to suboceanic regions, the accumulated heat is given up to the ocean. Re-solidification of the magma ensues, and the restoration of

the *former higher density causes the continents* to rise relatively to the oceans, and brings about the retreat of transgressional seas. *In this manner, the complete cycle* of a revolution finds explanation.

Mountain-building forces arising during *the climax of revolution originate* from two sources:—(*a*) the effects of the horizontal tide-generating force and of precessional force which, although probably considerable, have not yet been evaluated; (*b*) the effects of the changing area of the ocean-floor attending the expansion and contraction of the basaltic layer, whereby the oceanic area becomes alternately increased and diminished. Upon shrinkage the enlarged ocean-floor bears against the continents. Hence "the highest mountains confront the widest oceans."

Mountain-building is due much more to vertical than to horizontal forces. The mountains are not pushed up by lateral forces: these forces act upon the subsidising geosyncline to produce deformation of the semi-plastic materials. The mountains are elevated long after by the isostatic forces, the energy being traceable to the stored radioactive heat of prior ages.

Inter-revolutionary events consist of "preparatory" disturbances, due to local increase of liquefaction of the magma: also of "*sequential*" disturbances, due to relief of strain accumulated during revolution, and to the restoration of isostatic equilibrium.

The conditions now prevailing beneath the continents preclude the establishment of a steady state (that is, of thermal equilibrium) and in the past *always must have done so*.

The cyclical events outlined in the theory here adduced appear to be inevitable as a consequence of radioactivity and isostasy. Cyclical disturbances alone can explain the past history of the Earth's surface.

At the meeting held on Wednesday, May 16, the following communications were read:—

The Upper Ordovician Rocks of the South-Western Berwyn Hills, by W. B. R. King, O.B.E., M.A., F.G.S.

The Geology of the District around Corris and Aberllefenni (Merioneth), by Prof. W. J. Pugh, O.B.E., B.A., F.G.S.

A lecture on the Geology of Novaya Zemlya was delivered by Dr. Olaf Holtedahl, on Thursday, May 17, in the Geological Department, Imperial College of Science and Technology, Prince Consort Road, S.W.7. Prof. W. W. Watts, Sc.D., F.R.S., presided.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

PROCEEDINGS AT MONTHLY COUNCIL, HELD ON WEDNESDAY, MAY 2, LIEUT.-COL. E. W. STANYFORTH (PRESIDENT) IN THE CHAIR.

Among other business, the following reports were presented:—

Chemical.

Mr. Luddington reported that the Consulting Chemist had presented the list of *samples analysed by him for members* during the past month, and had submitted various matters arising out of his correspondence.

Research.

Mr. Adeane, *in the absence of the Duke* of Devonshire, reported that statements had been received as to the progress of the following experiments which were being carried on for the Society:—

(1) Norfolk Agricultural Station (barley and other cereals).

(2) National Institute of Agricultural Botany (oat trials).

(3) Mr. Arthur Amos (silage).

(4) Mr. Thomas Hacking (grassland improvement—Leicestershire).

(5) Professor Seton (grassland improvement—Yorkshire).

Wtih regard to the republication of the results of past experimental work of the *Society, it had been resolved that* Dr. Voelcker and Sir John Russel be asked to proceed at once with the collation of the material relating to cereals in the past volumes of the Society's Journal, as well as similar material available at Rothamsted, but that Lord Bledisloe and Mr. Orwin be consulted prior to the publication of the work or its reproduction in the Society's Journal.

It had been finally determined with regard to the yield trials of oats being conducted for the Society by the National Institute of Agricultural Botany that the contribution from the Society was not to exceed £816 for the two years.

Mr. Adeane moved the adoption of this report. As two of the experiments—one on pig feeding by Professor Wood and the other on silage by Mr. Amos—were being carried out at Cambridge, he suggested that if possible arrangements should be made so that members of Council who wished to do so could go to Cambridge after the Council Meeting on August 1. He proposed that

the Council Meeting on that day should be held at 10 o'clock, in order that those who wished to take part in the visit could catch an early train.

Mr. Dampier Whetham said that although he had no official connection with the School of Agriculture, he knew the views of Professor Wood and others concerned at Cambridge, and was able to support very warmly Mr. Adeane's suggestion.

The President asked if it was the wish of the Council, after hearing what Mr. Adeane had said, that they should hold their meeting at 10 o'clock on August 1.

This was agreed.

Other business having been transacted, the Council adjourned until Wednesday, June 6 (Derby Day), at 10 a.m.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Heavy Grade Egyptian Crude Petroleum, by W. A. Guthrie, F.I.C., F.R.S.E., etc.

(Owing to Mr. Guthrie's absence in Egypt, this paper was read by Professor J. S. S. Brame, F.I.C., F.C.S.)

According to Hume, seepages of oil at Zeitia, Gemsah and Gebel Tanka, the latter on the coast of West Sinai, led to the Egyptian borings for oil. Important supplies were first obtained at Gemsah in 1908, where the petroleum was present in porous dolomitic limestone associated with gypsum, of Miocene age. Subsequently in 1913 borings were commenced at Hurghada. These traversed the typical Miocene successecession as developed on the surface in the Zeit Hills—*viz.*, below a thick series of gypsum followed dolomitic limestone or the characteristic Globigerina Marl. Below this stratum is a series of sands and shales (including carbonaceous varieties), in which the main oil is present. A third small oilfield is the Abu Durba, on the west coast of Sinai, where there are indications of the former presence of oil in the Nubian Sandstone. Borings have shown that petroleum is present in gravels of igneous rocks occurring between the outcrop of the Nubian sandstone and the shore. Whether the oil is present in deeper seated strata has still to be shown.

The heavy grade crude petroleum is found at Hurghada (Rargada), 200 miles S.E. of Suez. From the striking of oil in the first well in October, 1914, until the beginning of the present year, 1,201,868 metric tons have been won. The present production averages 3,500 tons per week. A proportion of the production of the field is "wet"—*i.e.*, contains about 30 per cent. of salt water as a very refractory brine emulsion, difficult to de-emulsify.

In 1918 the author carried out experiments confirming that these emulsions were amenable to the electrical dehydrating treatment.

The oil is a mixture of paraffin base and asphaltic base petroleum; it has quite a pleasant smell, despite its sulphur content, and when seen in a thin film is brownish-black in colour, while the calorific value is just under 19,000 B.T.U.s per pound. It contains traces of Vanadium and Nickel. The ultimate analysis is: carbon, 85.15 per cent.; hydrogen, 11.71 per cent.; sulphur, 2.25 per cent.; oxygen and nitrogen (by difference), 0.89 per cent.

Although much study has been expended on chemical examination, this is still incomplete. The only practical method of separating the constituents is fractional distillation, which, at atmospheric pressure, alters the composition of the fractions. In order to obtain fractions having a closer relationship to the original crude oil, distillations were conducted right down to coke, under a vacuum of 28 inches, using liberal supplies of steam. The final temperature of the vapour was 223° C. In the earlier fractions from these vacuum distillations, very little, if any, bromine was absorbed; in the earlier fractions from an atmospheric distillation 3 to 10 per cent. unsaturated hydrocarbons occur. Moreover, in the later fractions from an atmospheric distillation as much as 40 per cent. of unsaturates have been found, while in the same fractions, from a vacuum distillation, these were from 10 to 20 per cent.

The oil, when distilled in the ordinary way for commercial products, yields 6 to 8 per cent. benzine boiling below 150° C., and 14 to 15 per cent. kerosine, boiling between 150 and 290° C.

The benzine and kerosine fractions can he refined to first-class products. The benzine is not entirely free from sulphur compounds but these are not present in an objectionable form.

The kerosine (specific gravity, 0.820 at 15.5° C.) can be refined to a water white kerosine of high illuminating value, by treatment with 2 per cent. of sulphuric acid, finishing with fuller's earth or florida clay treatment.

The residue is very thick and viscous, becoming semi-solid at temperature slightly below 15.5° C., and having a viscosity at 100° F. in Redwood's No. 1 Viscometer of anything from 5,000 to 7,500 secs. The viscosity cannot be determined at all in the No. 2 Viscometer at 32° F., or even at 60° F. The high viscosity is, of course, due to the asphalt and paraffin wax content, which amounts to 15.25 per cent. of the former, and 10.35 per cent. of the latter. The calorific value of the residue is 18,370 B.T.U.s.

On analysis a typical sample of the still coke gave: Carbon, 96.76 per cent.; sulphur, 2.96 per cent.; ash, 0.28 per cent.

"THE PHYSICAL CHEMISTRY OF THE PHOTOGRAPHIC PROCESS."

The Society will hold a general discussion on this subject on Monday, May 28 next, in the Hall of the Institution of Electrical Engineers, Victoria Embankment, W.C.2. Professor W. D. Bancroft, of Cornell University, will open the proceedings at 3 p.m. with an Introductory Address on *The Theory of Photography*. This will be followed by detailed consideration of the subject, subdivided as follows:—

I. "The Physical Chemistry of the Vehicle and of the Emulsion."

II. "Reactions in the Plate during Exposure."

III. "Development and Characteristics of the Developed Plate."

IV. "Adsorption Reactions in Photographic Films."

Each Section will be introduced by a Preliminary Address and followed by general discussion. Among those who will read papers are Dr. T. Slater Price, Dr. F. C. Toy, Mr. Olaf Bloch, Mr. T. Thorne Baker, M. Clerc, Prof. Luther, and Prof. Goldberg. Several communications will be made from Mr. S. E. Sheppard and other members of the staff of the Eastman Kodak Company, and papers are also expected from Dr. Chr. Winther, Dr. Luppo Cramer, and Prof. L. Plotnikov.

Between the afternoon and evening sessions a complimentary dinner will be given at the Hotel Cecil to Prof. Bancroft and the other guests.

Members of the Chemical Society are invited to attend this meeting. Full particu-
...btained from the Secretary of
...Street.

GENERAL NOTES.

SANITARY INSPECTION OF ARGENTINE AGRICULTURAL EXPORTS.

A recently issued Presidential Decree, which is to come into force in July next, lays down regulations for the sanitary inspection of agricultural products exported from the Argentine Republic.

The Minister of Agriculture is to organise in the ports of Buenos Aires, La Plata, Bahia Blanca, Rosario, in the city of Mendoza (and in other ports when convenient) an inspection service for plants, shoots, tubers, bulbs, seeds and grain, fresh fruits and vegetables destined for export, in order to ascertain their sanitary state, conditions of packing and shipment.

Exporters are required to apply to the Minister of Agriculture, in the prescribed form, for permission to export each consignment.

Detailed instructions respecting the nature of the inspection, analysis, or cleaning necessary for each category or class of produce are specified in the Decree, which provides for the issue of certificates if the goods are recognised as suitable for export.

A copy of the Decree in Spanish may be seen by persons interested on application to the Tariff Section of the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

FOREIGN SAMPLES EXHIBITION AT WALSALL.

An exhibition of foreign samples and catalogues held at the offices of the Walsal Chamber of Commerce on May 3 and proved one of the most successful display yet held at that centre.

The samples exhibited, particulars which appeared in the *Board of Trade Jou nal* of April 26 (page 501) proved of exce tional interest to the manufacturers of Wa sall and district, who expressed their abili to compete with the foreign-made article.

A full attendance was recorded, whi 124 samples and 150 catalogues were b rowed by firms who desired to consi carefully the question of export of simi goods. The fact that over 40 definite quiries were received for names of bu and information respecting export mat indicates that Walsall firms intend to m practical use of the lessons of the ex

LJUBLJANA TRADE FAIR.

The Department of Overseas Trade is informed that the Third Ljubljana (Laibach) International Trade Fair will be held from September 1 to 10.

There is a market in Jugo-Slavia for automobiles, parts and accessories; metal goods; celluloid products; chemical and pharmaceutical products; electro-technical and other machinery; bicycles and accessories; typewriting machines and ribbois; office equipment; perfumery; optical instruments; sports equipment; watches and clocks; jewellery and fancy goods.

Stand prices vary from 60 to 160 dinars per square metre, according to the position of the stand.

A booklet and specimen application form (in French) may be seen on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.—(*From the "Board of Trade Journal," May* 10.)

DYESTUFFS (IMPORT REGULATION) ACT.

APPLICATIONS FOR LICENSES IN APRIL.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during April has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 512, of which 430 were from merchants and dealers. To these should be added the 22 cases outstanding on April 1, making a total for the month of 534. These were dealt with as follows:—

Granted—331 (of which 318 were dealt with within seven days of receipt).

Referred to British makers of similar products—130 (of which 121 were dealt with within sevtn days of receipt).

Referred to Reparation Supplies available—56 (all dealt with within two days of receipt).

Outstanding on April 30—17.

Of the total number, 534, of applications received, 479, or 90 per cent., were dealt with within four days of receipt.

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.

On Friday, May 11, the Rt. Hon. the Viscount Chelmsford, G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., Chairman of the College Committee, unveiled the tablet commemorating the munificent gifts for the new chemistry building made by Sir Ralph Forster, Bt., J.P.

The chemistry laboratories were open to inspection after the ceremony.

NOTICES OF BOOKS.

Einführung in die Kolloidchemie, von PROF. DR. VIKTOR POSCHL. Sechste verbesserte Auflage. Pp. 158. Dresden and Leipzig: Verlag von Theodor Steinkopff. 1923. Price 3s. 1d.

The appearance of the sixth edition of this very clearly written *Introduction* shows how widely Prof. Pöschl's little volume is used for the study of Colloid Chemistry. It will certainly continue to fulfil the author's intentions, as expressed in the preface, as a text-book by those who wish to gain a clear conception of the phenomena in this branch of natural science.

His endeavours to establish colloid chemistry as an *exact* science will meet with general approval.

The book constitutes an interesting survey of the subject and gives a clear conception of various colloidal phenomena. It also points to the ways in which a knowledge of these phenomena can be utilised in dealing with other chemical and technical problems.

The advent of this edition is opportune since the elementary study of colloids will be included more and more in science curricula. Prof. Pöschl's book will therefore be found very valuable for students, since it is sound and precise, and will leave a correct impression in the students' mind. V.K.

Synthetic Inorganic Chemistry, by ARTHUR A. BLANCHARD, PH.D., and JOSEPH W. PHELAN, S.B. Third edition, entirely rewritten and greatly enlarged. Pp. XIV. + 321. London: Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, W.C. 1922. Price 15s. net.

The authors of this volume on practical inorganic chemistry rightly commence with an introduction on manipulation and general laboratory processes. Early chapters are devoted to the quantitative aspects of chemistry, solution, and experiments illustrating the theory of Ionisation.

Subsequent chapters give numerous methods of preparations of compounds, grouped according to the Periodic Classification of the elements. The preparations are followed by further illustrative experiments

and each chapter concludes with a set of questions designed to test how far the student has grasped the subject matter.

The volume abounds in explanatory details, and has evidently been revised in accordance with the latest knowledge, although in the case of the appendix on the *Periodic Classification of the Elements according to their Atomic Numbers and the Arrangement of their Electrons*, this seems to have been done rather hurriedly. The outstanding advantages outweigh any minor defects of this nature, which can be remedied in the next edition.

The practical exercises are arranged to follow lecture work. Practically every type of chemical reaction is exemplified in the course outlined. This is done in such a manner as to preclude the operations being conducted in a mechanical manner.

These are among the many good points to be noticed in a perusal of this work.

BOOKS RECEIVED.

The Examination of Hydrocarbon Oils and of Saponifiable Fats and Waxes, by PROF. DR. D. HOLDE. Pp. XIX. + 572. Second Edition. 1922. Messrs. Chapman & Hall, 11, Henrietta Street, Covent Garden, W.C.2. 30s. net.

Thermodynamics and the Free Energy of Chemical Substances, by GILBERT NEWTON LEWIS and MERLE RANDALL. Pp. XXIII. + 651. First Edition. 1923. Messrs. McGraw Hill Publishing Co., Ltd., 6 & 8, Bouverie Street, E.C.4. 25s. net.

Synthetic Inorganic Chemistry, by ARTHUR A. BLANCHARD, PH.D., and JOSEPH W. PHELAN, S.B. Pp. XIV. + 321. Third Edition. 1922. Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Strand, W.C.2. 15s. net.

Practical Chemistry, by E. J. HOLMYARD, M.A. Pp. XVI. + 264. 1923. Messrs. G. Bell & Sons, Ltd., York House, Portugal Street, W.C. 4s. net.

The Chemistry of Urea, by EMIL A. WERNER, M.A., Sc.D., F.I.C. Pp. X. + 212. 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 14s. net.

PUBLICATIONS RECEIVED.

The Board of Agriculture and Fisheries has issued a leaflet, No. 246, entitled *Prevention of Damage to Hides, Skins, and Wool*.

Among the most important live stock products, after the meat itself, are the hides of cattle and the wool and skin of sheep. These are, it is true, bye-products in the sense that the animals are primarily grown for meat and not for their hides or skins, but they are bye-products of very considerable value, and as such deserve more attention at the hands of farmers and others interested in the live-stock industry than they commonly receive.

The value of these bye-products is frequently depreciated by causes which are recognised as injurious in other ways, but which are not usually regarded as necessarily affecting the price which the farmer receives for his stock and produce. The loss in value thus caused is a serious matter.

Leaflet No. 242, *"Stripe" Disease of Tomatoes*, is abridged from an important article by S. G. Paine and W. F. Bewley in the *Journal of the Ministry of Agriculture*, January, 1920.

New Patents.

This list is specially compiled for The Chemical News, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

10583—Badische Anilin & Soda-Fabrik.—Production of tanning materials. April 18.

10804—Chemische Fabrik Auf Aktien vorm, E. Schering.—Manufacture of vaccines from bacteria. April 20.

10592—Kuhn, A.—Apparatus for extraction and removal of resin from solution in acid. April 18.

10883—Vogal, H.—Process for manufacture of colloidal sulphur. April 21.

Specifications Published this Week.

195710—Zahm, E.—Process and apparatus for concentrating liquids.

195753—Soc. of Chemical Industry in Basle.—Manufacture of vat dyestuffs derived from anthraquinone.

195798—West, J. H., Jaques, A., Tully, C. B.—Manufacture of hydrogen or gases rich in hydrogen.

Abstract Published this Week.

194244—Dyeing cellulose acetate.—British Cellulose & Chemical Manufacturing Co., Ltd., 8, Waterloo Place, London, and Bader, W., Spondon, near Derby.

The partial alkaline saponification of cellulose acetate threads, films, or fabrics, to facilitate dyeing, is carried out by first treating the goods with a hot or cold salt solution, and then saponifying with substantially cold caustic alkali. If desired, a little alkali or alkaline-earth hydroxide may be added to the salt bath, to prime the subsequent saponification. *Sodium, calcium, or magnesium* chloride are suitable salts for the pretreatment bath. Mixed goods containing cellulose acetate and cellulose threads may be treated by the process.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3293.

ɴ EXPLANATION OF THE THEORY ᴏF THE ROTATION OF THE ATOMIC NUCLEUS.

Part II.

By Herbert Henstock.

Before proceeding to apply the theory to specific cases there is one conception of a general nature, which should be realised in order fully to appreciate the workings of the nucleus. Let us consider two neighbouring atoms of a chain, the one positive, the other negative. The nucleus of the negative atom is using a considerable amount of its force in holding together the electrons of the unions of the chain, so that its power upon the side bonds is weakened, and therefore the atoms or groups attached to it are less strongly held, hence the greater ease with which such side atoms or groups are usually substituted. On the other hand, the nucleus of the positive atom, being repelled by that of the negative, does not exert so much of its force upon the electrons of the chain unions, with the consequence that its positive force shrinks away from these bonds and is exerted chiefly upon the side bonds, which accounts for the greater difficulty in replacing atoms or groups attached by these bonds: circumstances in many cases may, of course, modify these actions, but this is the general tendency in most cases.

Some Applications of the Theory to Inorganic Chemistry.

In appraising the value of a theory it is natural to consider the more difficult cases, and especially those where the difficulties have so far been unexplained, as being the more important or more interesting; but of necessity a theory must conform to the common cases as well as the extraordinary ones: a short general survey will therefore be given, which will include some of these interesting problems in their due order.

Hydrides, Halides and Hydroxides.[1]

Group[2] I., including Hydrogen.

General types[3] of the alkali halides and hydrogen halides, Fig. 1; Alkaline hydroxides, Fig. 2.

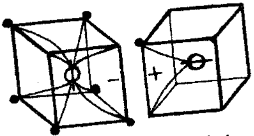


Fig I.

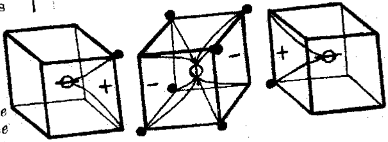


Fig 2.

[1] *In all following demonstrations where any halides, alkali metals, hydrogen or the OH group come into a compound their octets will be omitted and instead their symbols will be given with an arrow showing their point of union.*

[2] *Refers to the groups of the periodic table.*

[3] *All inner electrons have been omitted.*

In electrolytes the electron of the positive atom will pass over to the negative octet. For reasons, see *The Chemical News*, 1923, CXXVI., 133.

The hydrogen is united to oxygen, in the -OH group, by a co-valence bond, since oxygen is not strong enough in permanent polarity to wholly take over its electron; this co-valence permits the group to act as an entity; the permanent polarity of the oxygen is, however, thereby strengthened, and it can then take over the electron of a metal and form an electrovalence bond with it.

Tri atomic hydrogen will presumably be linked by partial valencies and will have the form, Fig. 3.

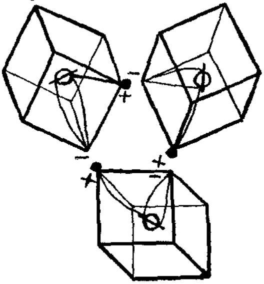


Fig 3.

The nuclei are only partially rotated, and there are three lines of force from each nucleus, where normally there should be but two, hence the three are considerably weakened, and the whole molecule will be very unstable.

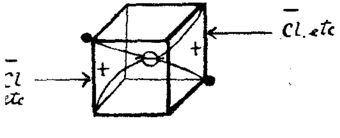


Fig 4.

Group II.

General types of the halogen compounds $BeCl_2$, etc., Fig. 4; hydroxides $Ca(OH)_2$, etc., Fig. 5.

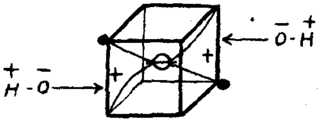


Fig 5.

These present little difficulty.

Group III.

General types of the halogen compounds as BCl_3, $AlCl_3$, Fig. 6.

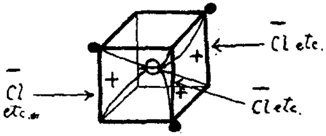
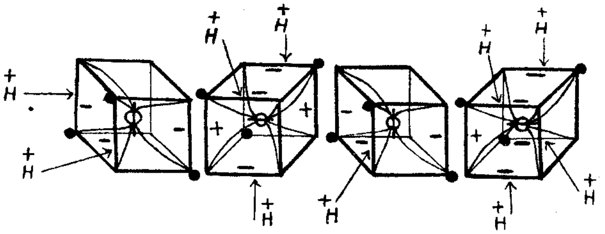


Fig 6.

The hydroxides are formed on the same plan by substituting -OH groups for halogens.

In this class, Boron forms several hydrides, notably B_4H_{10} and B_6H_{12}; according to Stock (*Ber.*, 1912, XLV., 3539) the former, on heating to 100°, forms B_2H_6, which is a gas, and this, when heated at 115° for some time, forms $B_{10}H_{14}$; he expresses surprise that these are formed and not BH_3: but according to this theory these compounds are just what might be expected. Boron evidently has a tendency to unite with itself like carbon, therefore BH_3 is not formed. B_4H_{10} will have the composition as indicated in Fig. 7, the cubes representing the boron atoms. It appears as an open chain.

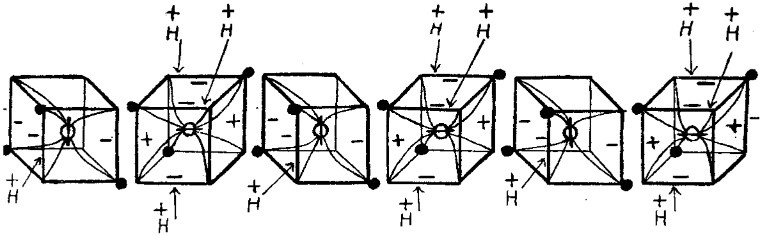


or

$BH_2 - BH_3 - BH - BH_4$

Fig 7.

B_6H_{12} will appear as a ring, Fig. 8, all the bonds being single ones.



or

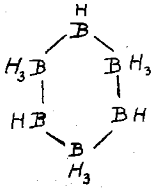


Fig 8.

$B_{10}H_{14}$ is a ring compound containing three double bonds. A double bond between two atoms of this element (see Fig. 9),

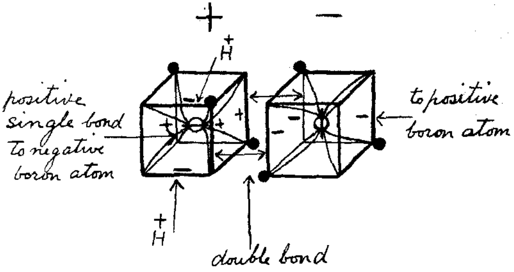
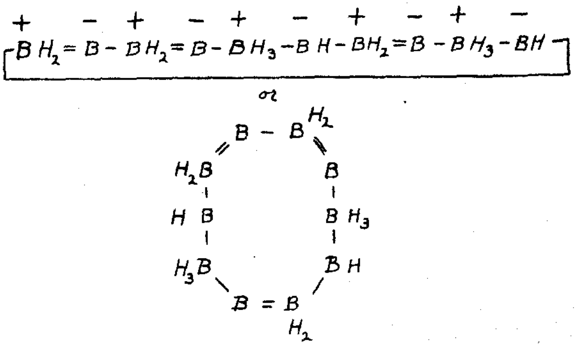


Fig 9.

leaves two negative bonds in the positive atom, but none in the negative atom; also from Fig. 8 it will be seen that in two atoms united by a single bond, the positive atom has three spare negative valencies and the negative atom only one; we can then write the formula—



in which it will be seen that the boron atoms are alternately tri and penta valent. It must be conceded that boron may be penta valent, otherwise these formulæ cannot be constructed: it is impossible to construct any on a purely tri valent basis.

The above formula can be seen more clearly on drawing out the octets and putting in the lines of force, which was the method by which the author arrived at it. B_2H_6 is as follows:—

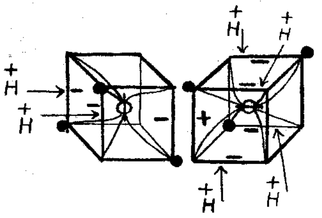


Fig 10.

It may be written $\overset{-}{BH_2}$-$\overset{+}{BH_4}$.

In all these boron hydrides it will be noticed that both positive and negative bonds come into play in the same atoms they are therefore unstable (see rule 2)*

Group IV.

General types, as CH_4, SiH_4, etc., Fig. 11; CCl_4, $SiCl_4$, etc., Fig. 12.

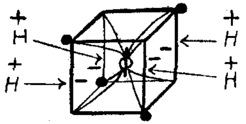


Fig 11.

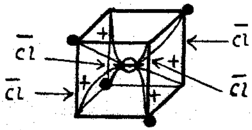


Fig 12.

(To be Continued.)

* *For rules see Part I. of this series (The Chemical News*, 1923, CXXVI., 263).

IS THERE AN ELEMENT OF ZERO ATOMIC NUMBER?

II.

By F. H. Loring.

In this Journal, May 18th, the subject of the above title was discussed. It was assumed that when dealing with series numbers, they should, if possible, be completed to their origins. Two series were given, and in each case when they were completed as far as possible to their origins, *i.e.*, without passing into negative values, they seemed to imply that an element should exist with zero atomic number; but there were other reasons given for doubting this possibility. The subject, however, merits further treatment.

It is of interest to consider this problem in its more realistic aspect. Numbers alone will not carry the argument very far. The figures shown in the scheme on page 307 had in themselves no remarkable significance; indeed, other numerical sets could be given, but the point made was that if there were two active elements preceding helium—hydrogen and one other—then the series as constructed ran 0, 1, 2, 3, etc., instead of 1, 2, 3, etc., as would be the case if there was only *one* preceding element.

Atomic numbers, as is well known, are intimately bound up with the net nuclear charge of the atom, and since this is positive the number is thus associated with a charge opposite to that of an electron. This being so, the question arises—Where does the unit positive charge representing unit atomic number reside? According to modern views based largely on the work of Rutherford, this unit would be the proton, and it resides in, or is, the hydrogen atom apart from its single electron exteriorily situated. Since the hydrogen atom can now be placed in the periodic table (see references in previous paper) and it is possible to remove from it its single electron, it is not stretching matters to regard the proton as properly classified, especially since the atomic numbers are nuclear magnitudes. The electron belonging to hydrogen can thus be ignored in the placing of the nuclear magnitude, the proton.

The electron, however, is not as yet placed, and since it cannot function by itself as a positive entity, like hydrogen minus its electron, it is natural to conclude that it cannot possess a normal atomic number, though it may enter into the nuclei

of atoms and condition them in terms of atomic number.

It may be jumping to a wrong conclusion to give the electron a zero number, but it is quite as reasonable a proposition as the assigning of its opposite type, the proton, to the hydrogen place, for in the latter case the hydrogen atom normally takes with it an electron. It might also be argued that since the atomic numbers are essentially positive electrically, the electron, if placed in any scheme, should have a negative place and not a neutral one, as represented by a zero number.

As a further consideration it is well to remember that the net nuclear charges of the atoms are to all practical intents and purposes their atomic numbers; and, therefore, the periodic scheme is one involving the classification of atomic nuclei. The nucleus is in fact the predominant conditioning or controlling factor in the atom; and the properties of all atoms seem to rest upon this nuclear magnitude as the sort of foundation on which the superstructure of the atom is built. The atomic numbers are magnitudes which govern the number and disposition of the external electrons that function in valency phenomena.

Another point to be considered is that in all the relations studied which involve protons and electrons there appears to be only one foundation, as it were, in the structural characteristics of matter, and all variations are due to those relative to that foundation. There are not two distinct electricities, but only one by comparison which may vary from zero to a maximum value representing positiveness, the electron being the agent of entity which brings about this change. If this is so, there can be no such thing as a negative atomic number, for the asymptotic limit, so to speak, is zero. The electric agent which brings about this change, the electron, cannot do more than neutralise a positive charge until it is practically zero. Since the relations studied are relative, this dual oneness of affairs is difficult to understand, and what appears to be a negative charge pure and simple must perhaps be judged in its relative aspect.

It is not possible to pass through zero with atomic numbers, but the negative electron may be given the zero place in the system of representation, inasmuch as it can, in its most advantageous position, only neutralise a single unit positive charge to zero. It is true that the picture can be represented in the reverse way, making the electron the main factor, but this does not harmonise with the atomic number conception based upon the positive charge of the nucleus of the atom which is fundamentally associated with its mass; or, at least, the discussion, to be consistent, must be from the standpoint of atomic numbers. Therefore, from the relative view given, there can be no *negative* atomic number, but it might represent zero charge, in which case the electron could be taken as a *zero-producing* quantity so far as atomic numbers are concerned.

It must be remembered that the series given on page 307 implies that the zero-atomic-number element is *active* yet without a positive charge. The electron is certainly active in the chemical sense, as it serves as a bond of union in chemical combinations, and it is without a positive charge—it is relatively negative in fact, for its addition to a positive nucleus reduces the charge as already discussed.

The conventions of language involving terms denoting *opposites* should be used cautiously, as it is the phenomena which should be pictured rather than the descriptive words as such (see notes below).

There is another development in this connection as discussed by Rutherford and by Eddington, affording a further view which will be developed in the next section.

Notes.—It should be appreciated that the process of electrification consists in transferring electrons from one body to another. An electric current is a flow or drift of electrons. The positive charge appears always to be associated with matter in that the charge appears in proportion as electrons are separated from matter, the term *matter* here referring to the protonic structure in which the main mass resides.

DISINFECTANT FLUID, TALLOW AND LINSEED OIL REQUIRED IN SOUTH AFRICA.

Mr. W. G. Wickham, H.M. Senior Trade Commissioner in South Africa, reports that the South African Railways and Harbours Administration, Johannesburg, are calling for tenders to be presented by Monday, May 28, 1923, for the supply of disinfectant fluid during the period 1 July, 1923, to 31 December, 1923 (Tender No. 441).

A copy of the tender form, specification and conditions of tender, can be inspected by British firms at the Department of Overseas Trade (Room 52), 35, Old Queen Street, Westminster, London, S.W.1.

The same Administration are calling for tenders, to be presented by Monday, June 4, 1923, for the supply of tallow, and also anti-friction grease, during the period July 1, 1923, to June 30, 1924 (Tender No. 448).

A copy of the specification, etc., may be seen at the Dept. of Overseas Trade (Room 53).

The South African Railways and Harbours Tender Board are calling for tenders, to be presented by Monday, May 28, for the supply of raw and double boiled linseed oil for the six months ending December 31, 1923 (Tender 439).

A copy of the specification, general conditions of tender, etc., may be seen at the Dept. of Overseas Trade (Room 53).

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY CONVERSAZIONE.

The following exhibits were shown on the occasion of the annual conversazione, held on May 16:—

DR. HELE-SHAW, F.R.S.: *Stream Line Filter.*

The Stream Line Filter, as its name indicates, causes the fluid which has to be filtered to flow with stream line motion. This is done by forcing the fluid between parallel sheets in a pack of such sheets made of material impervious to the fluid itself.

The space between the sheets can be regulated at will in such a way as to obtain films so attenuated that the matter in suspension, however minute, can be prevented from entering the interstices between the sheets.

The sheets may have a matted, or more or less rough, surface, but if the sheets are smooth a stream line pattern may be embossed on them either by dies or surface printing. The employment of sheets of a suitable kind of paper gives a simple and inexpensive filter for laboratory and other work, the filtrate being drawn from one tap and the residuum from another. The filter can be washed out without opening it.

THE GOVERNMENT LABORATORY (DR. FOX): *Nephelometer with Observation Tubes of Fixed Height.*

Two tubes of the same dimensions, containing the turbid liquids to be compared are placed in the path of a beam of light. Over the tubes and at right angles to the direction of the light are two Nicol prisms which can be rotated to adjust the zero. The polarised beams of light pass into separate total reflecting prisms arranged to reflect the light into planes perpendicular to each other. The beams then traverse a Lummer-Brodhun cube, and are brought into a rotatable Nicol prism through which the emergent beam enters the observation tube.

PROF. J. T. MACGREGOR-MORRIS and PROF. E. MALLETT: *Sand Figures showing the numerous resonant modes of Vibration of Telephone Receiver Diaphragms.*

A telephone receiver whose diaphragm is arranged in a horizontal plane is excited with alternating current supplied by a thermionic valve oscillator.

Sand is sprinkled on the diaphragm, and, as the frequency of the alternating current is progressively raised, the various modes of mechanical resonance appear with great sharpness. (Chladni's figures.)

At least seven modes of vibration are shown within the limits of audition. The frequencies of these have been compared with those obtained from both the membrane and the plate theories, and a graph is shown of the results.

SIR WILLIAM BRAGG, F.R.S.: (1) *Models showing Structure of Tartaric and Racemic Acid* (Mr. W. T. Astbury). (2) *Model showing arrangement of Molecules in Basic Beryllium Acetate.*

MR. E. E. BROOKS: *Photographs of Lines of Electric Force.*

Certain of the aniline dyes suspended in a dielectric liquid such as turpentine are found to give a very fair map of the electric field. The photographs shown deal with the more important special cases.

THE ROYAL SOCIETY: (1) *Centenary of Death of Dr. Edward Jenner.*

Certificate of candidature of Dr. Edward Jenner, elected a Fellow of the Royal Society, 1789.

(2) *Early Meeting Places of the Society.*
Photographs of Engravings showing the earlier meeting places of the Royal Society, namely, Gresham College (1660-1666 and 1673-1710), Arundel House, Strand (1666-1673), Crane Court, Fleet Street (1710-1780), Somerset House (1780-1857), Old Burlington House (1857-1873).

PROF. H. C. H. CARPENTER, F.R.S.: *Large Aluminium Crystals.*
Test pieces prepared from sheets and round bars, consisting of minute crystals—about 3,500,000 per cubic inch—have been converted into single crystals over the parallel portion of the test piece by a combination of mechanical strain and thermal treatment. When subjected to tensile stress these crystals become deformed in a peculiar way which depends, in the case of the sheet, on the orientation of the crystal. The round bars pull out so as to give a double groove instead of a cup and cone fracture as obtained from the microcrystalline test pieces. Remarkable twinning effects are also observed.

THE SCIENCE MUSEUM: *Copies of some Early Scientific Instruments.*
(1) The "Merkhet" or instrument used by the horoscope priests of Ancient Egypt to lay out temple axes, and to determine the hours of the night. *Circ.* 700 B.C.
(2) An Egyptian Waterclock from Karnak for recording the hours of the night by the fall of the water surface. *Circ.* 1400 B.C.
(3) An Egyptian Waterclock from Edfu for recording the passage of the hours by means of a rising water surace. Ptolemaic Period.
(4) A Roman Groma constructed from drawings and details supplied by Cav. Mateo Della Corte, Director of Excavations at Pompeii.

INTERNATIONAL WESTERN ELECTRIC COMPANY:
(1) *Watercooled Vacuum Tubes.*
This vacuum tube is of the same type as those used in the recent Transatlantic telephony test. A special feature of this tube is the copper-glass joint. Some parts showing the construction of the tube are also exhibited.
The photographs show a 100 Kw. tube and also some 10 Kw. tubes mounted ready for operation. Curves are also given showing the relation between Transatlantic signal strength and interference.

(2) *A Low Voltage Kathode Ray Oscillograph (in operation).*
The instrument consists of a glass tube in which a kathode ray is generated between a hot filament kathode and a small tubular anode. The ray is rendered visible by striking a fluorescent screen at the end of the tube. It is deflected with the help of two pairs of parallel plates set at right angles between which the ray passes. To the two pairs of plates two alternating potentials are applied: the fluorescent spot then traces out a curve which is a graph of the relation between the two potentials.
(3) *Rochelle Salt Piezo-Electric Crystals.*
A Rochelle salt crystal suitably mounted is shown used as a gramophone transmitter. The vibrations on the records are transmitted through the needle and cause deformations of the crystals. The deformations produce corresponding alternating differences of potential which, when applied to a telephone receiver, will reproduce the music very faithfully. The crystal is reversible and can be used as a loud speaking receiver. If alternating differences of potential are applied to the crystal the corresponding deformations can be made to cause air vibrations by suitably fitting a paper cone to it.

MR. CONRAD BECK:
(1) *A New Illuminator for Opaque Objects under the Microscope.*
A development of the principle of the old Lieberkuhn, but consisting of an aplanatic ring of glass silvered on back surface, enabling a short focus reflector of great light intensity to be used with powers as high as 4 mm. (1/6). The same illuminator can be used on powers from 40 mm. to 8 mm., a special type being made for 4 mm.
The objects shown illustrate its use with and without polarised light.
The latter method removes the glare caused by reflection at the object and enables true colours to be observed.

(2) *Illumination of Ordinary Objects with Polarised Light under the Microscope.*
Amphipleura Pellucida resolved into dots —1.4 N.A. Beck apochromatic object glass—immersion condenser full axial cone of light — crossed tourmalines — approximate size of dots 1,200,000 inch.
(*a*) Dark ground, illustrating advantage for distinguishing colour — method employed by Sir Herbert Jackson, F.R.S.
(*b*) Without dark ground, for resolving fine structure.

It was shown by Sir Herbert Jackson that this method enables the full resolving power of the microscope to be realised. Direct light is almost extinguished, and advantage is taken of the eliptically polarised light reflected from fine elements of structure, thus eliminating all glare, which has been demonstrated by Mr. Conrad Beck to be mainly due to reflections from the glass and slip.

THE CAMBRIDGE AND PAUL INSTRUMENT Co., LTD.: *A method of running a direct-current motor under a variable load, or on a variable voltage, in synchronism with a tuning fork.*

A phonic motor, designed by Dr. A. B. Wood, which is driven by a tuning fork (50 V.D.), moves a contact on a circular rheostat, the latter being rotated by the motor which it is wished to control. If the latter gains or loses speed relatively to the phonic motor, the rheostat is adjusted automaticelly to correct the speed of the motor.

The mechanism exhibited forms the driving part of a Plotting Chronograph designed by Dr. W. Rosenhain, F.R.S., and is exhibited by the courtesy of the Director of the National Physical Laboratory.

NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY (DR. C. S. MYERS, F.R.S.): *Examples of Research Work*—(1) *Investigations in a Coal Mine* (MR. ERIC FARMER); (2) *Specimen Curves of Improved Output and Wastage* (DR. G. H. MILES and MR. ERIC FARMER); (3) *Intelligence Tests* (DR. CYRIL BURT); (4) *Vocational Selection Tests for Entrants to the Engineering Trades* (MR. M. H. TAGG).

MESSRS. J. J. GRIFFIN & SONS, LTD.:

(1) *The "Boys" Integrating and Recording Gas Calorimeter.*

In this calorimeter, which is of the water flow type, the water used is measured and doled out positively at such a rate that it will be heated 10° C. by the combustion of half a cubic foot of gas per hour if the gas is of the "declared" value, whatever that value may be. The gas is doled out positively at atmospheric pressure at that rate corrected for temperature, pressure and contained water vapour accurately to one part in 1,000. The means used for adjusting the rate are a ball-cylinder-disc integrator and epicyclic gearing, called the thinking machine. A recording drum and driving gear of extremely simple construction keep a record of the ever-changing volume factor of the gas. The heat interchanger of folded sheat lead autogenously soldered is also a new construction, as is the method used for the soldering. The operative thermometers are brass boxes with elastic accordion tops filled with amyl alcohol. These through a lever system working in three dimensions of space, operate a pen moving one inch for each degree centigrade. This rests on the middle line of the chart if the gas is of its declared value, and it moves one-tenth of an inch for each 1 per cent. of increase or decrease. An Amsler integrating wheel gives the average value since it was last set. The paper is ruled and marked in half-hours, days and half-days as it passes through the machine. Distilled water produced by an automatic still only is used, and this is circulated and cooled by the operation of a small hot air engine. The one-wheel clock which governs all the mechanism is driven by the waste water.

(2) *New small "spot test" Calorimeter.*

This is the meter and interchanger of the recording instrument adapted for personal observation. The final temperature is reached in 10 minutes from lighting the gas, and the tiresome meter proving operations are not necessary.

MR. D. NORTHALL-LAURIE: *Photomicrographs of Crystals in Colour mounted to show changing tints.*

When crystals are examined under a microscope with polarised light with the addition of a selenite plate cut of such thickness to show a green colour and a red colour when rotated through an angle of 45°, the predominant tint changes from green to red. The Paget viewing screen used for the Paget colour photographic process being composed of minute squares of green and red, neglecting for the moment the smaller blue squares, enables it to be possible by changing the register of the viewing screen when combined with the transparency to imitate on the lantern screen the effect produced when using polarised light. Colour photographs are taken of the subject and the slides are so constructed to allow of the viewing screen being slowly moved across the transparency. In this manner the tint of the slide changes from green through various intermediate colours to red, depending upon the relative position of the slide and screen. Various slides of subjects suitable for exhibiting this effect have been constructed on this principle.

THE NATIONAL PHYSICAL LABRORATORY:

(1) *Iron Mercury Calorimeter* (DR. EZER GRIFFITHS and MR. F. H. SCHOFIELD).

The calorimeter consists of a cylindrical block of iron with a hole for receiving the specimen and a lid which serves also as a container of mercury. Arrangements are made for flooding the hot specimen with mercury. The apparatus is particularly useful for dealing with materials of low thermal conductivity or materials which react with water.

(2) *X-Ray Spectra of Alloys* (DR. E. A. OWEN and MR. G. D. PRESTON).

Spectrographic curves showing the atomic structure of pure metals and alloys. The method depends upon the presence of a large number of small crystals in plates of the material. The effect is enhanced by polishing and etching.

(3) *Photomicrographs of Woods* (DR. G. W. C. KAYE and MR. W. F. HIGGINS).

Certain woods of low density, viz., *Ochroma lagopus* (Balsa wood), *Apeiba tibourbou* and *Paulownia imperialis* (Japanese Kiri wood), have been found to possess very low thermal conductivities. Photomicrographs of these are shown side by side with those of pine and beech, and the marked difference in the thickness of the cell walls is easily seen.

MR. E. HATSCHEK: *Imitations of Organic Forms by Drops and Vortices of Gelatin.*

Permanent "hanging drop" and vortex forms can be obtained by allowing gelatin sol to run into suitable coagulating solutions, the temperatures and densities being so adjusted that the gelatin sets when the desired form has developed. Owing to shrinkage a number of features, such as radial ribs, undulating membranes, stellate and crenated discs, etc., appear, which are absent in liquid models. Further modifications can be introduced by causing permeable or semi-permeable membranes to form at the proper time; models of the red blood corpuscle and segmented forms are produced by this procedure.

PHYSICAL DEPARTMENT, ROTHAMSTED EXPERIMENTAL STATION, HARPENDEN: *Flocculation and Deflocculation in Soils.*

The phenomena of flocculation and deflocculation are of great importance in soils, as they are associated with the formation of tilth. The experiments include measurements of the volume changes of soil resulting from alterations in its moisture content, and a demonstration of the influence of lime on the flocculation of soil samples taken from successive depths of an experimental plot. The automatic electrical balance, devised by Prof. Oden and Dr. Keen, furnishes a continuous time record of the accumulating weight of deposit from a soil suspension. Analysis of the time-weight curve thus obtained, leads to a distribution curve showing the relation between the weight (or number) of particles and the effective radii; the shape of the curve varies according to the degree of dispersion of the soil suspension.

Certain practical consequences are illustrated by means of dynamometer record-charts of draught of ploughs under different conditions.

[Shown by Dr. B. A. Keen, with Mr. E. M. Crowther and Mr. W. B. Haines.]

MR. F. HARRISON GLEW: *A Levitating Magnet.*

This experiment shows a bar magnet of cobalt steel, floating by repulsion above the opposed poles of a fixed magnet, at a vertical distance of half-an-inch, or more, according to the strength of the magnetic field.

The floating magnet is free to move vertically and may be made to oscillate up and down in its glass enclosure. The experiment fails with ordinary magnet steel, as reversal of polarity takes place in the intense magnetic field necessary for flotation.

NATIONAL INSTITUTE FOR MEDICAL RESEARCH (DR. LEONARD HILL, F.R.S., and DR. A. EIDINOW): *Effect of Temperature on the Biological Action of Light.*

DR. W. LAWRENCE BALLS, F.R.S.: *Mirror-Image Structures in Cell-walls of Cotton Hairs.*

The cotton hair has a characteristic convoluted form; these convolutions have long been known to be both right and left-handed in any one hair. Such reversals of the external spiral are primarily due to reversals of a spiro-fibrillar internal structure in the cellulose wall, these in their turn being due to growth-causes as yet unknown.

The preparation is a longitudinal section of a cotton hair, through a reversal. The single layer of wall thus observed between

crossed nicols, with light elliptically polarised through quartz plates, shows the structural reversal clearly by a change in the interference colours. If now the circular stage of the microscope be rotated, it will be found that the positions of maximum extinction are also reversed on either side of the micro structural reversal, the optical axes being thus related to the spiral-fibril axes, and not to the cell-axis. This indicates the existence of a definite pseudo-crystalline space-lattice structure.

NATIONAL INSTITUTE FOR MEDICAL RESEARCH (DR. E. H. J. SCHUSTER): *A New Recording Kata-Thermometer.*

MR. E. B. MOULLIN: *A Direct Reading Thermionic Voltmeter.*

The voltmeter employs the rectifying property of the Thermionic Vacuum tube. If an alternatiug P.D., whose mean value is zero, is applied between grid and filament, a current is produced in the anode circuit whose mean valut is not zero. The value of the current so produced is used as a measure of the alternating P.D. applied to the instrument. The exact conditions obtaining at the time of calibration are readily reproduced in a simple manner.

The readings of the instrument are unaffected by the frequency of the applied alternating P.D., and experiment shows that if this frequency is changed from 10 per second to a million per second, the error produced is less than 2 per cent.

The electrostatic capacity of the voltmeter is of the order of 20 cms and the power it absorbs at full scale is about 50 ergs per second.

MR. GEORGE H. GABB: *Bust of Galileo, carved in pear wood: Probably a work of about* 1650-70.

This bust, formerly in the Methuen Collection, is rather larger than life size, and stands 39 inches high.

The socle consists of a group of astronomical emblems, carved in high relief; surmounted by a globe, around which, in a belt, are carved the Signs of the Zodiac.

At the back of the bust, in a circular glazed recess, is preserved a relic of Galileo; a piece of crimson velvet, with silk fringe, possibly a piece of the covering of his academic chair.

This has been removed carefully, and was shown in the small glass case.

MR. WALTER HEAPE, F.R.S.: *Exhibition of three series of photographs illustrative of the following:—*

(1) Heape and Grill's rapid cinema machine designed to take photographs at rates from 500 to 5,000 per second. (This machine is now in use at Shoeburyness for recording the results of gunnery experiments.)

(2) Film photographs taken at the rate of 2,500 per second of a 15 in. glass vacuum globe (Osram) broken by a hammer. (This shows what occurs during the complete break up of the globe in about one-twentieth of a second.)

(3) Film photographs taken at the rate of 2,000 per second of a 5 in. solid rubber ball weighing $2\frac{1}{4}$ lb. shot from the mouth of a 2 1/16th in. diameter gun against a steel target.

They show the extraordinary contortions of the ball from the instant when it is shot off a tee by the head of a tompion fixed in the mouth of a gun until it rebounds from the target—that is, a flight of about 1/40th of a second.

MR. H. J. BUCHANAN-WOLLASTON: *On the Value of Markings on Herring-Scales as a Means for Estimating Age and Growth Rate of the Fish.*

MR. PERCY R. LOWE: *Variation in Red-Legged Partridges (Alectoris rufa).*

MR. H. GRAHAM CANNON: *Beetles showing transplanted heads.*

PROF. J. W. GREGORY, F.R.S., and MR. C. J. GREGORY: *Fossils from the Devonian, Carwoniferous and Triassic Rocks of Chinese Tibet.*

The collections were made by Prof. Gregory and Mr. Gregory during the Sladen Trust Expedition, 1922.

DEPARTMENT OF ZOOLOGY, BRITISH MUSEUM (NATURAL HISTORY) (MR. C. TATE REGAN, F.R.S., and MR. M. A. C. HINTON).

(1) *Deep-sea Cables Damaged by Shark Bites;* (2) *Contents of a Crocodile's Stomach;* (3) *Modifications of the dentition in some African Vertebrates.*

BOTANY SCHOOL, CAMBRIDGE (MR. JOHN WALTON): *A New Method of isolating Mummified Fossil Plants for purposes of Microscopical Examination.*

THE DIRECTOR, ROYAL BOTANIC GARDENS, KEW:
(1) *Efwatakala Grass—Melinis minutiflora P. Beauv.*
(2) *Rubiaceous Plants with Bacterial Nodules in the Leaves.*

MR. H. TAVERNER: *Stereo-photo Micrographs of Hydracarina (Water Mites) in Natural Colours.*

RESEARCH DEPARTMENT, WOOLWICH: (1) *Detection of Feeble X-ray beams by Smoke Clouds.*

In this method a smoke cloud, having a flat top, is produced in a small chamber, and above this cloud is placed an electrode maintained at a potential about 400 volts above earth. The cloud is then interposed in the path of an X-ray beam, and some of the ions thus produced attach themselves to the smoke particles, which are then drawn up from the top of the cloud under the influence of the electro-static field.

The movement of these particles is observed by an ultra microscope. The exhibit illustrates the application of the method to the detection of feeble X-ray beams refected from crystals.

(2) *Chronograph, for use with a photographic Recorder.*

(3) *Autographic Recording of Dilation of Solids at High Temperatures.*

MR. S. G. BROWN, F.R.S.: *The Frenophone.*

MESSRS. ADAM HILGER, LTD.: *Optical Apparatus for Research.*

(1) Vacuum Grating Spectrograph for photography of the Schumann and Lyman Regions.

(2) Diffraction Gratings ruled at the National Physical Laboratory.

(3) Interferometer for measuring the aberrations of lens systems.

(4) Lummer Gehrcke Parallel Plate with resolving power of 850,000. Made for the Physical Laboratory of the University of Toronto.

(Shown by kind permission of Prof. J. C. McLennan, F.R.S.)

NATIONAL INSTITUTE FOR MEDICAL RESEARCH (MR. J. E. BARNARD, MR. JOHN SMILES and MR. F. WELCH):

(1) *Improvements in the method of Microscopical Observation known as "Dark-ground Illumination."*

(2) *An Expermental Demonstration with the Microscopic Interferometer.*

The Microscopic Interferometer is intended for the double purpose of testing microscope objectives and similar optical combinations, and for use as a microscope of high accuracy.

The experiments shown indicate the effect of alteration of tube-lengths on the zonal corrections of an objective. As the illuminant used in this case is a mercury vapour lamp, the demonstration is confined to the three brightest colours emitted by mercury vapour.

When used as a microscope the accuracy of the fine-adjustment motion is some ten times greater than in any ordinary microscope. Thus, if ultra-violet light is the illuminant, successive images in any single wave-length can be obtained with precision.

DR. IRVINE MASSON: *Apparatus for Measuring the Compressibility of Gases.*

The body contains four holes, communicating with each other and with a space in which a plunger works through a special gland. The cavity is full of mercury; in each hole is set a glass tube filled with about 15 cc. of gas. By screwing in the plunger the mercury forces the gases into the visible capillary portions of the tubes where their volumes are measured, the capillaries having previously been calibrated. One tube contains a standard gas and thus serves as an accurate pressure-gauge.

The advantages of this form of Andrews' original pattern lie chiefly in its freedom from leakage at high pressures and in its capacity for four samples at once. It has been used at 450 atmospheres' pressure.

ANGLO-PERSIAN OIL CO., LTD.: *Lubricating Oils under Electrostatic Stress.*

The Electrostatic Stress is applied by means of a disc of brass resting on the smooth surface of a piece of lithographic stone, commonly called printer's stone.

The metallic disc is connected to a negative source of supply of 105 volts whilst the stone is connected by a copper plate (on which it rests) to the opposite pole of the supply.

Under these conditions, it can be shown by a balance system of suspension that the

electrostatic stress is capable of supporting a considerable weigat.

If the smooth surface of the stone is covered with a thin film of lubricating oil, and the potential difference applied as before, a decrease in the electrostatic pull is observed; this pull varies with different oils.

Sir Richard Paget, Bart., gave a demonstration on *The Nature and Reproduction of Vowel Sounds*. Mr. Walter Heape. F.R.S., also gave a demonstration on *Cinematograph Exhibition*. A series of films, the photographs of which were taken at rates varying from 2,000 to 3,000 per second.

THE ROYAL SOCIETY.

Thursday, May 17.

Papers read:—

A. E. H. Tutton, F.R.S. (1) *A Universal Interferometer*. (2) *A Wave-length Torsometer, and its Use with the Universal Interferometer.*

(1) The instrument is an interferometer of general application, for the measurement of very short distances, small deformations or changes of dimensions, or minute amounts of motion, by the interference-band scale of half wave-lengths of light. It was suggested by the success attained with the comparator for standards of length, designed for the Standards Department of the Board of Trade, and described to the Royal Society in 1909.

Its essential feature is a travelling microscope driven by a specially constructed fine screw along a very true V-and-plane guiding bed, so steadily that one of the two glass reflecting surfaces concerned in producing the interfering monochromatic light rays is actually carried rigidly with it, so that the amount of its motion is measured directly in interference bands. The microscope and its mountings, the large driving wheel which works the fine screw by means of a connecting flexible shaft, endless screw and worm-wheel, are similar to the pair of microscopes carried by the standards comparator, but the one microscope is more conveniently arranged for the special purpose in view, and has several minor improvements, including better resolution of Grayson-ruling fiducial marks, combined with greater working distance, and more convenient lighting of these 40,000 to the inch rulings.

The interference apparatus is practically identical with that of the comparator, consisting of the same type of autocollimating telescope with micrometer eyepiece, and vacuum tube on the elbow tube, a constant deviation prism for the selection of the monochrocatic radiation to be used, and large truly worked glass interference discs. The telescope is mounted to the right, and the driving wheel to the left, and the 30-inch long V-and-plane bed, in its rigid carrying plinth-bed, is supported on pillars at the Airy positions for no flexure, the whole being counted on a heavy solid rectangular base. The large middle space on the latter, and that underneath the arch, are available for the accommodation of whatever object, or apparatus carrying the object and possibly causing its motion, is brought to measurement. A large circular work-table, provided with every possible requirement of adjustment, is supplied in this clear middle space, for the convenience of the support of the object or its manipulating apparatus.

(2) This is a refinement of the Voigt instrument for determining the torsion constants of miniature bars of crystals and other small bodies. The essential difference is that the two optical levers of Voigt are replaced by radials which move the two sliders carrying Grayson-ruling fiducial marks, referred to in the preceding communication. The new torsometer is essentially composed of a miniature lathe-bed, carrying two similar but mutually reversed wheel-and-chuck fittings, the chucks for gripping the object bar ends, and the wheels, which move solidly with the chucks, for delivering the force-couple at one end and holding it firmly at the other, the two ends being interchangeable, either wheel being capable of locking fixation or of driving by a power band. The band passes round the lower half of that pulley-wheel on a standard. The end depending from in front of the latter terminates in a loop of the cord-band, into which the book carried by the weight can be allowed slowly to fall, until the whole weight is acting in twisting the object bar. The apparatus of Voigt for bringing the weight into action is replaced by the far more delicate one belonging to the elasmometer, the interference apparatus described by the author in 1904 for determining Young's modulus by the bending

of bars or plates. The weight can be delivered by this apparatus by either a coarse or a very fine movement, as required or desired.

When in use the torsometer is supported on the work-table of the universal interferometer, described in the preceding communication, where it can be rigidly clamped and delicately adjusted, so that the two aluminium radials carried by the object bar near its two ends, just clear of the chuck-grippers, are in contact near their upper terminations with the blunt knife-edge ends of the two sliders. The table adjustments permit matters to be arranged so that the Grayson-ruling signal is centred under the microscope when the radial under observation is just in complete contact with the slider. On delivering the weight and effecting the twist, the slide and signal move, and the movement is followed by driving the microscope by the big wheel of the interferometer until the signal mark is again centred, the number of interference bands effecting their transit the while being carefully counted.

L. N. G. Filon, F.R.S., and F. C. Harris. *On the Diphasic Nature of Glass as shown by Photo-elastic Observations.*

A block of flint glass was heated to about 400° C., when it showed some signs of softening; it was then allowed to cool under longitudinal pressure. On removing the pressure it was found to have become permanently doubly-refracting. The residual stress which should produce the observed amount of double-refraction is calculated by a new method, and the result shows that this residual stress does not balance according to the laws of statics. It is deduced that a "crypto-stress" exists, which does not manifest itself optically.

This leads to the conclusion that the glass is not homogeneous, but behaves as a mixture of two components or phases. A possible interpretation of the results on this hypothesis is put forward.

Papers read in title only:—

C. E. Inglis. *Stress Distribution in a Rectangular Plate having Two Opposing Edges sheared in Opposite Directions.* Communicated by Prof. E. G. Coker. F.R.S.

The type of deformation dealt with in this paper may be termed a pure mechanical shear, in contradistinction to pure shear as usually understood in stress analysis. The deformation is produced as follows:—

Imagine a thin rectangular plate bounded by two horizontal lines AB CD and two vertical lines AD BC. The two horizontal edges while remaining straight and unchanged in length and in distance from one another are displaced longitudinally in opposite directions, the vertical edges being kept free from applied stress. The plate being thin, the distribution of stress consequent on this deformation is regarded as two-dimensional and the stress components are obtained *via* solutions of $\nabla^4 V = 0$. Two different sets of functions satisfying this equation are evolved, and by methods of Harmonic Analysis they are combined to satisfy the prescribed boundary conditions to a high degree of approximation.

Particular attention is given to the stress distribution along the horizontal centre line. This stress starting from Zero at the free edge mounts up rapidly, and for a plate in which the length is considerable compared with the depth, the stress soon assumes a constant value; but before doing so, it overshoots this value, and the curve of stress distribution in consequence develops humps near the free vertical edges. If the length—breadth ratio of the plate is 2 to 1 these humps combine to give a flat-topped curve. If the plate is square the coincidence of the humps makes the curve approximate to a parabola.

These characteristics were first brought to light by Prof. Coker, who examined this particular stress distribution by Optical methods. The results obtained in this paper are in close agreement with his determinations. This investigation reveals the existence of large stresses at the corners of the plate, a state of affairs confirmed by reference to Prof. Coker's original coloured photographs.

T. H. Havelock, F.R.S. *Studies in Wave Resistance—Influence of the Form of the Water-plane Section of the Ship.*

In these calculations the ship is represented by a vertical post of infinite depth whose horizontal section is similar to the water-plane section of a ship. Expressions for the wave resistance are developed and are evaluated in terms of Bessel and Struve functions of which tables are available. The level lines of the model are varied while the displacement is kept constant; and in this manner a comparative study is made of

such problems in ship resistance as the effect of finer lines and greater beam, and of the difference between straight and hollow lines. Numerical calculations are made for four models, and the results are shown graphically and analysed in relation to experimental data.

W. M. H. GREAVES. *On a certain Family of Periodic Solutions of Differential Equations, with an Application to the Triode Oscillator.* Communicated by Prof. H. F. Baker, F.R.S.

An application is made to the equation of Appleton and Van der Pol for the Triode oscillator. It is shown that this equation can be reduced to a particular case of the above equations, and that the series for the periodic solutions which were obtained in a purely formal manner by Dr. Appleton and the writer in a recent issue of the Philosophical Magazine are convergent for sufficiently small values of some of the quantities involved.

ROYAL INSTITUTION.

On Tuesday, May 22, PROFESSOR FLINDERS PETRIE began a course of three lectures at the Royal Institution, on *Discoveries in Egypt;* on Thursday, May 31, SIR WILLIAM BAYLISS will deliver the first of two lectures on *The Nature of Enzyme Action*; and on Saturday, June 2, DR. A. W. HILL the first of two on *The Vegetation of the Andes and the New Zealand Flora.*

The Friday evening discourse on May 25 will be given by SIR ASTON WEBB on *The Development of London*, and on June 1 by PROFESSOR H. A. LORENTZ on *The Radiation of Light*, and on June 8 by MISS JOAN EVANS on *Jewels of the Renaissance.*

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated:—

The Influence of the Temperature upon the Action of Invertase, and a Theory on the Mechanism of the Action of Invertase, by BUNSUKI SUZUKI.

Chemical Investigation on Japanese Minerals containing Rarer Elements. Part V. Analysis of Beryl from Ishikawa, Iwaki, by TAKU UYEMURA.

On the Preparation of β-Oxymethylamine and its Salts, by SIN-ITI KAWAI.

The Constitution of Pyrethronic Acid, by RYO YAMAMOTO.

NOTICES OF BOOKS.

Practical Chemistry, by E. J. HOLMYARD, B.A. Pp. XVI. + 267. London: G. Bell & Sons, Ltd., Portugal Street, W.C. 1923. Price 4s. net.

The author has divided his laboratory textbook in two parts. The elementary portion includes a wide range of simple and very suitable experiments, introducing young students to chemical principles and laws. These experiments have evidently been so chosen that general chemical manipulation and different types of operations will all be carried out in the practical study of such matters as the simple laws, equivalence, the common gases, acids, bases and salts.

The second part contains sections on more advanced experiments in inorganic chemistry, such as the more difficult preparations, and the general reactions of the metals. There is a lengthy section on Volumetric Analysis, and a few gravimetric exercises are given.

An excellent feature of this practical volume, primarily intended for use in schools, is the inclusion of a series of experiments in Physical Chemistry. These, like the others, and the twenty or so Organic Preparations given in the final section, are described with adequate detail, so that the students may be largely left to themselves to arrange the apparatus and conduct the experiments with the minimum of help.

However good a laboratory manual may be, it cannot completely supersede personal supervision in practical work, but Mr. Holmyard's textbook should prove of the greatest value in the teaching of practical chemistry. J.G.F.D.

BOOKS RECEIVED.

Qualitative Organic Analysis: An Elementary Course in the Identification of Organic Compounds, by OLIVER KAMM. Pp. VII. + 260. First Edition. 1923. London: Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, W.C.2. 12s. 6d. net.

The Phase Rule and the Study of Heterogeneous Equilibria: An Introductory Study, by A. C. D. Rivett, M.A., B.Sc. (Oxon.), D.Sc. (Melb.). Pp. 204. 1923. Oxford: The Clarendon Press. 10s. 6d. net.

The Chemistry of the Inorganic Complex Compounds: An Introduction to Werner's Co-ordination Theory, by Dr. Robert Schwarz. Authorised Translation by Lawrence W. Bass, Ph.D. Pp. X. + 82. 1923. London: Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, W.C.2. 8s. 6d. net.

The U.S. Dept. of Agriculture have just issued a bulletin, No. 1,146, *The Influence of Copper Sprays on the Yield and Composition of Irish Potato Tubers*, by F. C. Cook,

Tubers from copper-sprayed potato plants at the time they were large enough for analysis, usually contained more solids, starch, and nitrogen than the tubers from unsprayed vines. The starch content increased approximately 50 per cent. as the tubers matured, while dextrose disappeared and sucrose was materially reduced. Early varieties of potatoes showed a decrease in their sugar content accompanying an increased starch content in the copper-sprayed tubers during the early stages of development. The proportion of insoluble ash decreased during the growth of the tubers, although the total ash content remained constant. Total nitrogen increased. The figures for soluble, coagulable, and particularly the monoamino and amide nitrogen increased as the tubers matured.

The proportion of tubers to green vines appeared to be higher for the copper-sprayed than for the unsprayed plants.

Average data for seven States in 1919 showed the food value of an acre of copper-sprayed potatoes to be 839 pounds more than that for an acre of noncopper-sprayed potatoes. Two factors, increased yield (48 bushels an acre) and an increase of solids (5.6 per cent.), are involved.

Tubers from several varieties of potatoes from a northern State were higher in solids than tubers of the same varieties grown in a southern State.

A larger yield of potatoes was secured from copper-sprayed than from check or noncopper-sprayed vines. Late blight (*Phytophthora infestans*) is eliminated as a necessary factor in the case.

When a lime spray containing no copper was used on one occasion, the yields of tubers were decreased. Pickering-lime-water spray and a barium-water spray gave practically the same increase in yield and in solids of the tubers as a Bordeaux spray. The copper in the spray seems to be the essential factor.

The Forty-seventh Annual Report of H.M. Inspectors of Explosives (1922) has been issued for the Home Office by H.M. Stationery Office, Price 6d. Pp. 36.

This report deals with matters arising out of the operation of the Explosives Act, 1875. These include Inspection, Accidents, Accounts, and comments on Accidents abroad, Experiments, Use of Explosives in Coal Mines, Petroleum and Carbide of Calcium. An appendix classifies the accidents for the period.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

11003—Agricultural Developments Co. (Pyrford), Ltd.—Manufacture of nitrogenous fertilisers. April 23.

11082—Borchers, W.—Process for refining crude chromium alloys. April 24.

11389—Borchers, W.—Ferrous alloys. April 27.

11110—Carbide & Carbon Chemicals Corporation. —Process of oxidising dibenzyl. April 24.

11000—Christensen, C. P.—Manufacture of calcareous and nitrogenous fertilisers. April 23.

11526—Evans, E. V.—Treating gases for removing carbon disulphide. April 28.

Specifications Published this Week.

195998—Buchner, Dr. M.—Production of pure alumina.

196002 Cumming, A. C., and Klarit, Ltd.—Decolorisation and clarification of fats, oils, sugars, and other liquids, and adsorptive materials for use therein.

196012—Vielle, J. A.—Process for the manufacture of insecticidal and fungicidal preparations.

196115—Phillipson, G. A.—Process and apparatus for drying and neutralising sulphate of ammonia.

Abstract Published this Week.

194208—Phosphatic fertilisers.—Soc. Anon. Products Chimiques et Engrais L., Bernard. Mesvin, Cipley, Belgium.

Calcium phosphate.—A fertiliser is obtained by heating together a homogeneous mixture of a phosphate rock, blast-furnace slag or feldspar, and bye-products containing alkalies such as residues from sugar mills or distilleries, or wool grease. The residue containing alkalies may be employed as such or may be first calcined and ground. The mixture of the materials may be effected wet or dry and the heating may be at 900-1,300° C.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3294.

AN EXPLANATION OF THE THEORY OF THE ROTATION OF THE ATOMIC NUCLEUS.

PART II.

BY HERBERT HENSTOCK.

(*Continued from Page* 325.)

Carbon has been included in order not to spoil the sequence of the elements, but it is proposed to discuss organic problems separately.

The case of stannous chloride is also postponed until those cases where distortion of the octet is considered.

Group V.

General types, as NH_3, PH_3, AsH_3, etc., Fig. 13.

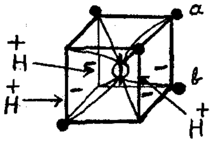


Fig 13.

In these compounds the stability decreases with increase of atomic weight, that is to say, the negative bonds are weakened or the octet electrons are not so strongly held by reason of the successive layers of inner electrons. One result of this is that the negative bond a-b (Fig. 13) in nitrogen is stronger than those in phosphorus or arsenic, with the consequence that nitrogen is more basic and so will form more stable compounds by means of that bond.

Such nitrogen compounds as NH_4Cl, NH_4NO_3, etc., will be formed on the general equation expressed in Fig. 14.

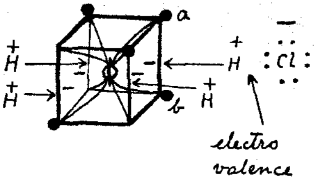


Fig 14.

The electrolyte HCl unites with ammonia by the negative bond a-b: the nitrogen in ammonia is negative in alternate polarity and is trivalent. It is a general rule, put forward by Lowry (lecture before the Faraday Society, Nov. 20, 1922), and also by Sidgwick (lecture before the Chemical Society, March 1, 1923), that when an atom shares two electrons with another, both electrons being supplied by one atom, then that atom acquires a positive charge; that is to say it loses part of its octet, and so the nucleus gains more power over the remainder. The atom which supplies no electrons acquires a negative charge, due to the extra electrons in its octet. This means that each atom slightly alters its *permanent* polarity, and this acts upon the nucleus of each and revolves it, making the alternate polarities change their signs. The constitution of ammonium chloride will then be represented by Fig. 15.

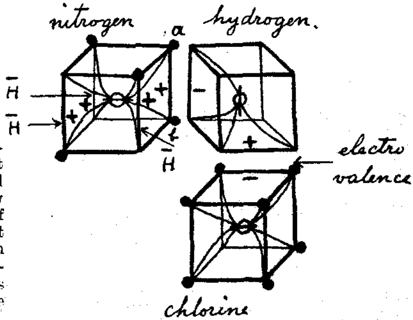


Fig. 15.

The key atom is the nitrogen, and the undoubted cause of its being so is the partial loss of the two electrons of the bond a-b, which slightly alters the permanent polarity causing the nucleus to revolve and the valency of the nitrogen to be raised. The bond a-b becomes positive and so also do those bonds uniting the three hydrogen atoms of the ammonia, whose nuclei revolve, making them negative in alternate polarity only: the nucleus of the fourth hydrogen atom also revolves, and it becomes negative, but in permanent as well as alternate polarity, hence the difference between the action of this and the other three. This fourth hydrogen atom unites with the chlorine, in the electrovalence bond, by one of its positive edges, but since it is united to the nitrogen by a normal edge therefore this union is stronger than the electrovalence bond, so that the whole of the NH_4 is a fairly stable entity and can act as a group.

Ammonium hydroxide will be represented by Fig. 16.

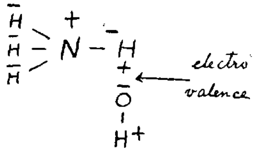


Fig. 16.

the extreme instability of which is apparent.

The fact that ammonium hydroxide is not so strong a base as the alkali metal hydroxides is due to the intervening fourth hydrogen atom with its inherent weakness where positive and negative edges both come into play (see rule 2). Organic tetra alkyl ammonium bases are as strong as the metallic alkalis, but the very simple explanation of this will be included amongst the organic compounds.

Those hydrides of the types NH_2-NH_2 or PH_2-PH_2 will have the general formula as in Fig. 17.

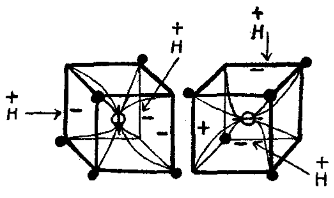
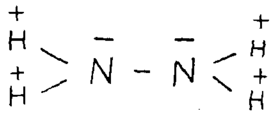


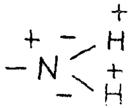
Fig. 17.

In hydrazine the positive nitrogen atom is united to hydrogen by negative edges, which makes the molecule unstable (rule 2) and accounts for this compound being less stable than those of the NH_3 type.

The positive nitrogen atom is an example of how one cannot strictly label all atoms completely positive or negative. In writing



the facts are not properly expressed, for no wholly positive or wholly negative bonds ever unite two atoms, their alternate polarities must be opposite. A more explicit method would be to label the second nitrogen thus—



which would show where the weakness of the molecule lay.

The phosphorus hydride $P_{12}H_6$ will be found to have the following constitution, if it be worked out in a similar fashion to those already shown for boron. It is a ring containing three double bonds, in which the phosphorus is tri valent. Thus:—

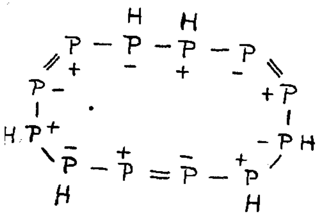


Fig 18.

The general types, NCl_3, PCl_3, $AsCl_3$, tc., are represented :—

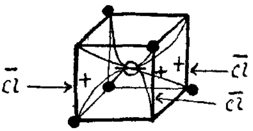
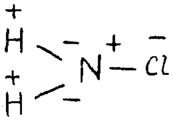


Fig. 19.

The chlorine, bromine, etc., are united to positive bonds, but nitrogen is an element fairly strong in negative permanent polarity and it is only in those compounds where the electrons of the bond $a-b$ (Fig. 13) are shared with another element that it becomes positive and basic, hence when this bond is unoccupied the nitrogen atom tends to unite along negative edges (as in ammonia, Fig. 13), in order to form stable compounds. In the case of these halogen compounds this tendency is not fulfilled, which accounts for the extreme instability of NCl_3, etc.

Mono chlor amide will have the constitution—



where the nitrogen is united by negative edges to the hydrogen and by a positive edge to the chlorine: the molecule is therefore unstable (rule 2).

The general types, PCl_5, $AsCl_5$, may be constituted as shown in Fig. 20.

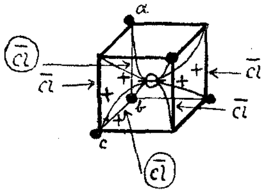


Fig. 20.

The two chlorine atoms in the rings are the two extra ones, and they may unite with the positive bonds $a-b$ and $b-c$, but both of them will be weak because there will be two electrons at each of two corners (rule 6). These two bonds are the only two spare positive ones, each of the others has one of its electrons already shared with another chlorine atom. In this case the nucleus of the phosphorus atom will not revolve since two electrons are supplied by the two extra chlorine atoms.

Holroyd (*Chemistry and Industry Review*, 1923, XLII., 348) suggests that *phosphorus penta chloride should be* constituted in an analagous fashion to ammonium chloride and should be an electrolyte: he proposes to carry out experiments to verify this, and should his surmise prove correct, PCl_5 will be represented by Fig. 21.

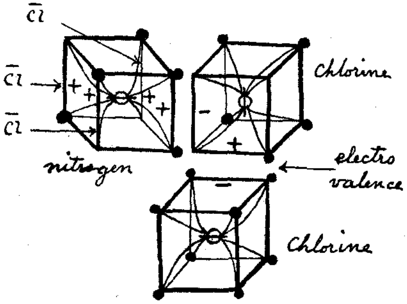


Fig. 21

It will be interesting to see which formula the results of these egperiments will substantiate.

Hydroxylamine will have the constitution shown in Fig. 22.

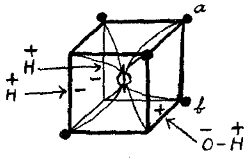


Fig. 22.

Rule 2 makes this an unstable compound: it decomposes at about 15°. According to this formula the hydroxylamates are formed with bases. The oxonium salts will be constituted similarly to the ammonium salts, but with the OH group still attached to the nitrogen. The bond *a*-*b* (Fig. 22) will act with acids exactly as that already described for ammonia (Figs. 14 and 15). The oxygen of the OH group may form a double bond with the nitrogen and the hydrogen go on to the nitrogen, but this oxygen atom would not come into the bond a-b (Fig. 22) uniting the group to an acid, so that quadrivalent oxygen does not come into the question.

Group VI.

General types, H_2O, H_2S, are shown in Fig. 23.

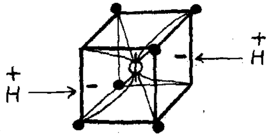


Fig 23.

H_2O_2 and H_2S_2 will be represented by Fig. 24.

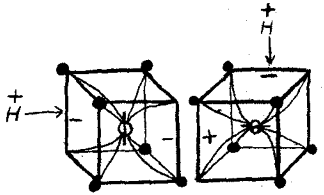


Fig 24.

In the positive atom, both positive and negative bonds come into play (rules 1 and 2), which accounts for the instability of the molecules. The remainder of the polysulphides of hydrogen may be represented somewhat similarly, and the same may be said for sulphur chloride, S_2Cl_2, but each chlorine atom will be united to a positive bond in both atoms of sulphur.

Group VII.

General types, HF, HCl, etc., see Fig. 1.

Group VIII.

General types, $FeCl_2$, $CoCl_2$, etc., will have a structure similar to Fig. 4, and types $FeCl_3$, $CoCl_3$, etc., similar to Fig. 6.

One difference between these elements and those of groups II. and III. is that these may have varying numbers of electrons in their octets. (See Bury, *J. Amer. Chem. Soc.*, 1921, XLIII., 1602). This fact makes the whole group very complicated: each series of compounds of this group should be worked out separately.

Chemical Research Laboratory,
School Gardens,
Shrewsbury.

GENERAL NOTES.

The Department of Overseas Trade has issued a *Report on the Economic and Financial Conditions in Germany, to March*, 1923, by J. W. F. Thelwall, Commercial Secretary to H.M. Embassy, Berlin, assisted by C. J. Kavanagh, Commercial Secretary, Occupied Territory, etc.,

Cologne. Pp. 158. Price 4s., or post free 4s. 2½d.

The report contains much valuable information regarding the internal and foreign trade of Germany for the year under review. The conditions prevailing in the various industries are given, and the effect of the continued occupation of the Ruhr is also indicated.

The supplementary statistics occupy 17 appendices.

MARKET FOR SURGICAL INSTRUMENTS, NEEDLES, AND RUBBER GOODS IN SPAIN.

Captain U. de B. Charles, Commercial Secretary at Madrid, reports that a demand exists in Spain for surgical instruments, needles and rubber goods, and that the moment is favourable for the introduction of British made articles. German manufacturers have hitherto had a practical monopoly of the trade, but the surtax on depreciated currency, which increases the duty by about 80 per cent., together with the high prices fixed in pesetas, make sales almost impossible, and supplies from Germany are now running short.

Opportunities of entering the Spanish market will be greatly enhanced if correspondence is conducted in Spanish.

The Department of Overseas Trade will supply British firms lists of likely importers and dealers in these articles.

The following headings of the Spanish Customs Tariff relating to surgical articles are quoted for information:

Articles of rubber for hygiene, orthopædic or medical purposes, without admixture of other materials—6 pesetas per kilog.

Medical and surgical apparatus and instruments: (1) of metal—10 pesetas per kilog; (2) of other materials—5 pesetas per kilog.

Orthopædic apparatus—3 pesetas per kilog.

The above duties are quoted in gold pesetas. When the amount of duties is tendered in notes of the Bank of Spain or Spanish silver coins, a surcharge is imposed. This varies monthly, and for May is fixed at 25.51 per cent.

GERMANY'S TRADE AND INDUSTRY IN APRIL.

Mr. H. N. Sturrock, the Commercial Secretary at Berlin, has forwarded to the Dept. of Overseas Trade a report on German trade and industry during April.

There has been no important change in the economic situation during April. Business continued quiet in the first half of the month. On the 18th, however, in consequence of the renewed fall of the mark, a small revival of trade took place. On this day the Reichsbank were unable any longer to hold the mark, which had remained [illegible] since the end of January.

In the retail trade, disinclination to buy began gradually to disappear; there was even a lively demand from the 18th to the 20th.

In occupied territory, the French succeeded in increasing the despatch of coal and coke. The quantities transported did not, however, amount to one-sixth of the deliveries under the Reparations programme.

MINING.

Coal.—The pit-coal production in Upper Silesia proceeded without disturbance, and is estimated at about 760,000 tons. The demand for Upper Silesian large coke continued. The large imports of British coal led to the accumulation of stocks, and any palpable improvement on the coal market cannot be expected until a change in the general situation or an increase in exports takes place. Stagnation also occurred in the Central German brown coal district.

Potash.—The unfavourable development of market conditions continued. There was also no improvement in foreign sales of potash products.

The sales of chemical bye-products of the potash industry improved with the rise in foreign bills towards the end of the month. Bye-products obtained by electrochemical process found a good market during the whole month, particularly abroad.

ELECTRO-TECHNICAL INDUSTRY.

In the electro-technical industry a further decline of business activity was recorded. The difficulties in the way of obtaining coal and semi-manufactures owing to the occupation of the Ruhr were overcome, but delivery contracts were delayed by transport difficulties.

CHEMICAL INDUSTRY.

The falling off in the demand for chemical preparations and ceramic chemicals, which became noticeable immediately after the unexpected rise of the mark, gave place at the beginning of April to a brief revival. The world's market price has, in part, been reached and, in part, exceeded. In particular, German prices for chemicals are higher than those of America, especially as

that country, unlike Germany, enjoys very favourable Customs treatment, not only by Entente countries, but also by Czecho-Slovakia and Poland. It is, therefore, urgently desired that the export duty for laboratory chemicals and ceramic chemicals be soon still further reduced in view of the enormous foreign competition.

GLASS INDUSTRY.

In the sheet glass industry, raw material deliveries were satisfactory. There was scarcely any inland demand, and exports decreased by a third as compared with March, as it was not possible to compete with Belgian and Czecho-Slovak prices. The Export Association of German Sheet Glass Factories have issued new offers, taking into consideration the reduction of the export duty to 1 per cent.

In the hollow glass industry the supply of raw materials and coal was satisfactory. Owing to the high costs of production inland business fell off considerably. Restrictions of operations occurred on a large scale, and a number of furnaces were put out.

LEATHER INDUSTRY.

Only urgent requirements were covered at the beginning of April. Later, as in the case of raw hides and skins, business improved.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, MAY 31, 1923.

Papers read:—

E. GRIFFITHS, D.Sc., and G. W. C. KAYE, D.Sc.—*The Measurement of Thermal Conductivity, No. 1.* Communicated by Sir Joseph Petavel, F.R.S.

G. W. C. KAYE, D.Sc., and J. K. ROBERTS.—*The Thermal Conductivities of Metal Crystals. I.: Bismuth.* Communicated by Sir Joseph Petavel, F.R.S.

C. V. DRYSDALE and S. BUTTERWORTH.—*The Distribution of the Magnetic Field and return Current round a Submarine Cable carrying Alternating Current.* Communicated by F. E. Smith, F.R.S.

SIDNEY RUSS, D.Sc.—*The Effect of X-rays of different Wave-Lengths upon some Animal Tissues.* Communicated by Prof. A. W. Porter, F.R.S.

Papers read in title only:—

E. F. ARMSTRONG, F.R.S., and T. P. HILDITCH, D.Sc.—*A Study of Catalytic Actions at Solid Surfaces. Part XI.: The Action of Alumina and certain other Oxides in promoting the Activity of Nickel Catalyst.*

N. K. ADAM.—*The Structure of Thin Films. Part IV.: Benzene Derivatives. A Condition of Stability in Monomolecular Films.* Communicated by W. B. Hardy, Sec. R.S.

N. K. ADAM.—*The Structure of Thin Films. Part V.* Communicated by W. B Hardy, Sec. R.S.

W. B. RIMMER.—*The Spectrum of Ammonia.* Communicated by Prof. A. Fowler, F.R.S.

ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on June 1, at 9 o'clock, will be delivered by PROF. H. A. LORENTZ, HON. F.R.S., HON. M.R.I., Haarlem University. The subject is *The Radiation of Light.*

On Thursday, May 31, SIR WILLIAM M. BAYLISS, LL.D., D.Sc., F.R.S., gave his first lecture on *The Nature of Enzyme Action.*

On Saturday, June 2, ARTHUR W. HILL, Sc.D., F.R.S., Director, Royal Botanic Gardens, Kew, will lecture on *The Vegetation of the Andes.*

On Friday evening, June 15, SIR ERNEST RUTHERFORD will give his postponed discourse on *Life History of an Alpha Particle of Radium*, and his concluding lecture on *Atomic Projectiles* on Saturday afternoon, June 16.

PHYSICAL SOCIETY OF LONDON.

A meeting was held on Friday, May 25, at the Imperial College of Science, South Kensington, S.W.

The following papers were read:—

The Effect of Torsion on the Thermal and Electrical Conductivities of Metals, by PROF. C. H. LEES, D.Sc., F.R.S., and J. E. CALTHROP, B.A., B.Sc.

The Use of the Wien Bridge for the Measurement of the Losses in Dielectrics at High Voltages, with Special Reference to Electric Cables, by A. ROSEN, B.Sc., A.M.I.E.E.

A Demonstration of an "Experiment on the Production of an Intermittent Pressure by Boiling Water" was shown by C. R. Darling, F.I.C., F.Inst.P.

A Demonstration of "A Novel Instrument for Recording Wireless Signals" was given by N. W. McLachlan, D.Sc., M.I.E.E.

PROCEEDINGS AT THE MEETING HELD ON MAY 11, 1923, AT THE IMPERIAL COLLEGE OF SCIENCE, ALEXANDER RUSSELL, M.A., D.Sc., IN THE CHAIR.

The Duddell Medal.

Sir William Bragg, F.R.S., Chairman of the Duddell Memorial Committee, handed over to the President of the Physical Society a copy of the Memorial Medal, together with the dies and a certificate for the unexpended balance of the memorial fund. In the course of his remarks Sir William Bragg said that the committee had been formed in response to a widely felt wish that the work of this distinguished scientist should be commemorated in a suitable manner. A sum of no less than £700 had been subscribed, thanks in the main to the energy of Mr. R. S. Whipple, secretary to the committee. As regards the design of the medal, very great pains had been taken to ensure that it should be worthy of the memory of the dead and of the art of the nation to which he belonged. The work had been entrusted to Mrs. Mary Gillick, and the committee felt that their choice had been very fully justified by the result. Mrs. Gillick had devoted immense trouble and care to her task, and the medal she had produced was one of which the Society might be proud.

Photographic slides of the medal were exhibited. On the obverse is a miniature of Mr. Duddell; and on the reverse a figure symbolical of Science examining the world as she finds it, with legends "The Physical Society of London" and "*Rerum Naturam Expandere.*"

Dr. Alexander Russell, President, in accepting the medal on behalf of the Society, said that he did so with gratitude to all who had combined to make this memorial possible, and particularly to Sir William Bragg and Mr. R. S. Whipple, whose initiative had set the undertaking on foot, while their perseverance had carried it to such a successful issue. He had been associated with Mr. Duddell at the City and Guilds Technical College and in other connections. He had always marvelled at the encyclopædic character of Mr. Duddell's technical knowledge, which, coupled with his mechanical skill and inventive ingenuity, had enabled him to make so many contributions of permanent importance to the progress of science and of industry. He had been Treasurer, Member of Council, and Vice-President of the Physical Society, and President of the Institute of Electrical Engineers.

Sir Richard Glazebrook said that it gave him great pleasure to express his warm and intense admiration for Mr. Duddell. The latter had been a cordial helper of the National Physical Laboratory, especially during the war, and had always been ready to give generously from his great store of knowledge and of scientific resource. His memory would be kept alive not only by his own work, but by the admirable medal which had been designed; and it was to be hoped that the latter would encourage others to follow his example and to engage in the field of scientific enterprise in which Duddell had been such a prominent worker.

TERMS OF AWARDS OF THE DUDDELL MEDAL.

The following resolution was adopted by the Council on May 11, 1923:—

Duddell Memorial Medal.

Resolution.—That the £400 War Loan 5 per cent. 1929/47 Inscribed Stock be accepted in trust from the Duddell Memorial Fund Committee, and that the income therefrom be expended in accordance with the following regulation:—

A bronze medal shall be awarded by the Council not more frequently than once a year to persons who have contributed to the advancement of knowledge by the invention or design of scientific instruments or by the discovery of materials used in their

construction. The award shall be made without restriction as to nationality or Fellowship of the Society. A parchment Certificate of Award and a sum of money may accompany the medal.

Should more than one person be connected with the invention or discovery for which the award is made, the Council may, at its discretion, present more than one medal and apportion the money accordingly.

The terms of awards shall not be varied except by Special Resolution passed by the Society at a General Meeting and confirmed at a subsequent meeting.

The Eighth Guthrie Lecture was delivered by J. H. Jeans, D.Sc., LL.D., F.R.S., who took as his subject *The Present Position of the Radiation Problem.*

Since about 1900 it has been obvious that classical dynamics are in conflict with experience in certain respects, and particularly with respect to the radiation problem. The observed discrepancies suggest that the laws of nature must in some way be discontinuous. To explain the observed nature of black-body radiation Planck propounded the quantum theory; in the hands of Bohr it soon became apparent that the quantum theory contained also the clue to the line spectrum. Hence arose hopes of rapid development which should explain the whole of the radiation problem and reduce molecular physics to order. Progress, however, has been slow and difficult, and what progress there has been is concerned with the structure of matter and not with radiation.

Einstein's hypothesis of light quanta appeared to possess obvious advantages, but has had to give way before the destructive criticism of Lorentz and others, and the direct experimental test of G. I. Taylor.

The different methods of interchange of energy between matter and ether or radiation may be classified as sub-atomic, atomic, and mass transfers. Typical of the first is the emission or absorption of radiation by a Bohr atom; of the second the motion constituting heat in a solid; and of the third the transmission of momentum occurring when a beam of radiation falls upon the surface of a perfect reflector. An examination of these leads to a consistent view, namely, that physical and chemical transfers take place by quanta, while mechanical transfers take place according to the classical laws.

As an example of the application of case of the exchange of energy between a free electron e and a field of radiation X may be considered. It appears probable that in such a field the mechanical force on the electron is not represented by the expression eX. The interchange of energy cannot be covered by the classical laws; neither can it take place by quanta. It thus seems probable that no exchange of energy at all can occur between a free electron and a field of radiation. A conception in regard to this which was used by Einstein in 1917 appears difficult to interpret except on the view that electric forces are a manifestation of a sub-universe more fine-grained than anything we have yet imagined. Many possibilities must be explored before we are driven to believe in a sub-universe of this kind.

Discussion.

Sir Oliver Lodge said he shared the enthusiastic admiration which the audience had manifested for the lecturer's work. He would seize the opportunity of asking him one or two questions, and particularly, how he would define the temperature of radiation in a vacuum. As regards the stability of the orbits in an atom, how would Dr. Jeans view the suggestion that circular orbits, which are free from tangential acceleration, are stable; and that when disturbed an electron spirals down to a successive circular orbit, radiation taking place since now the *speed* is varying? Such a change would be of finite duration, not instantaneous.

Dr. Jeans replied that by the temperature of radiation in a vacuum he meant the temperature of matter which could be in equilibrium with space containing that radiation. The word *stability* denoted a conception that had been left behind by the quantum theory, which only thinks of *states*. The notion of asymptotic spirals seems open to the fatal objection that each circular orbit must be quitted determinately for the nearest orbit, whereas in reality each orbit may be quitted for any one of a number of possible orbits. The passage from orbit to orbit may be supposed to occupy a time equal to some 1,000,000 light periods.

A hearty vote of thanks to the lecturer was moved by Dr. C. Chree, seconded by the Lord Rayleigh, and carried by acclama-

THE OPTICAL SOCIETY.

A meeting of the Optical Society was held at the Imperial College, Imperial Institute Road, on Thursday, 24 May, when the sixth of the series of lectures dealing with the evolution and development of optical instruments was delivered. It was entitled: *Telescopes before the early part of the Nineteenth Century*, and the lecturer was MR. DAVID BAXANDALL, A.R.C.S.

It was illustrated by exhibits from the collection in the Science Museum.

THE INSTITUTION OF MINING ENGINEERS.

NOTICE AND AGENDA-PROGRAMME OF GENERAL MEETING, AT GLASGOW, ON JUNE 12TH, 13TH, AND 14TH, 1923.

As previously announced, the seventy-ninth general meeting of the Institution of Mining Engineers will be held at Glasgow, by invitation of the President and Council of the Mining Institute of Scotland, on Tuesday, Wednesday, and Thursday, June 12th, 13th, and 14th, 1923.

TUESDAY, JUNE 12.

General meeting at the Royal Technical College, George Street, Glasgow, by kind permission of the Board of Governors.

The following papers will be read (or taken as read) and submitted for discussion:—

Coal-dust as an Explosive Agent (with special reference to the experimental work of the United States Bureau of Mines), by GEORGE S. RICE.

Summary of Research Work carried out for the Committee on "The Control of Atmospheric Conditions in Hot and Deep Mines."

The Recent Search for Oil in Great Britain, by H. P. GIFFARD, M.A., B.Sc.

A Volcano in the Bathgate Coalfield of West Lothian, by H. M. CADELL, B.Sc., F.R.S.E.

The Hurlet Sequence in Renfrewshire and Dumbartonshire, and the Evidence of the Basin Structure in the Coalfields of Scotland, by DAVID FERGUSON.

Excursions, to which ladies are also invited, to the Royal Technical College, Messrs. Mavor & Coulson's Works, and the collieries of the Fife Coal Co., have also been arranged.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

A Wireless Section meeting will be held on Wednesday, June 6, when a lecture entitled *Wireless Direction-Finding in Steel Ships* will be given by C. E. HORTON.

ROYAL SOCIETY OF ARTS.

On Friday, June 1, at 4.30 p.m., there will be a lecture before the Indian Section, entitled *The Participation of India and Burma in the British Empire Exhibition*, 1924, by AUSTIN KENDALL, I.C.S., retd., Secretary, Indian Advisory Committee. Sir Charles Campbell McLeod, Member, Board of the British Empire Exhibition, will preside.

THE FARADAY SOCIETY.

THE ELECTRONIC THEORY OF VALENCY.

A general discussion on the above subject is being arranged by the Faraday Society, to be held at Cambridge on July 13th and 14th next. Prof. G. N. Lewis will open the proceedings on the Friday afternoon with a general Introductory Address, and he will probably be followed by Mr. R. H. Fowler, who will contribute a paper intended to open discussion on the physical and inorganic side of the subject. Among those expected to speak are Sir J. J. Thomson, who will be in the chair, Sir Ernest Rutherford, Sir Wm. Bragg, and Prof. W. L. Bragg. The Saturday morning session will be devoted chiefly to applications of the theory in organic chemistry. Sir Robert Robertson, President of the Society, will preside, and opening papers will be given by Prof. T. M. Lowry and Dr. N. V. Sidgwick. Among those expected to speak are Prof. W. A. Noyes, Sir Wm. Pope, Prof. A. Lapworth, Prof. I. N. Heilbron, Dr. W. H. Mills, Prof. J. F. Thorpe, and Prof. R. Robinson. On the Friday evening a complimentary dinner will be given to Profs. Lewis and Noyes and other guests, at Trinity Hall. Arrangements are being made to accommodate those attending the meeting in one or other of the colleges, and it will be possible to include a limited number of non-members of the Society. Particulars may be had from the Secretary of the Faraday Society, 10, Essex Street, London, W.C.2.

THE FARADAY SOCIETY.

GENERAL DISCUSSION ON THE PHYSICAL CHEMISTRY OF THE PHOTOGRAPHIC PROCESS.

At the meetings on May 28.

The Physical Chemistry of the Vehicle and of the Emulsion, by T. SLATER PRICE, O.B.E., D.Sc., F.I.C.

Of the substances which were early used in making photographic emulsions, gelatin and the silver haloids are still those which give the best results. Even at the present day we do not know what causes the sensitivity of an emulsion, or if the manufacturer has obtained this information, he has not published it. If the same gelatin is sent to two different firms, the one may reject it as unsuitable whilst the other is just as likely to say that it is eminently satisfactory. One cannot deduce from this that if the acception or rejection is based on tests other than the making of an emulsion, the two firms have come to different conclusions as to the causes of sensitivity, since the methods used in making emulsions vary considerably.

In discussing the properties of gelatin it may be of advantage to contrast them with those of collodion, the other medium largely used for photographic emulsions. Collodion differs from gelatin in that it is insoluble in water, a mixture of alcohol and ether being generally used as the solvent. This fact at once limits its applicability. The influence of temperature on the viscosity is also very different with gelatin and collodion. Gelatin sols have the advantage that at the temperatures at which emulsions are made they are quite fluid, whereas at lower temperatures their viscosity increases enormously and at ordinary temperatures they set to a stiff gel, no evaporation of the solvent being necessary before setting takes place. Because of this, as soon as an emulsion has been made, it can be "set" quite readily. In addition to this influence of the hydrion concentration there is also the effect of the degradation products which are always present in gelatin. Hitherto no suitable method has been devised of estimating the amount and effect of these degradation products, but it may be mentioned that considerable progress has been made towards obtaining a gelatin which may be classed as a unitary product.

The readiness with which a gelatin gel swells in water is an important factor, both in the preparation of the emulsion and in development and fixing. Swelling is very sensitive to the influence of various salts, and especially to that of acid or alkali. During the manufacture the "set" emulsion is shredded and washed to remove soluble salts; the washing is generally done with tap or with spring water, both of which contain calcium and magnesium salts, which repress swelling, and consequently the gel does not increase in volume to undesirable proportions. If distilled water were used, it would not only be very costly, but also the emulsion would swell so considerably that not only would the characteristics of the emulsion produced be altered, but the succeeding operations would have to be modified.

As compared with collodion, the dried film of gelatin, as found on photographic plates or papers, offers many advantages. When a collodion film dries there is a tendency for it to become horny on the surface, and since it is insoluble in water hindrance is thereby offered to the penetration of developing and fixing solutions. The gelatin film, however, readily swells in the developer solution, which then diffuses into it almost as readily as it would do into pure water, and hence reaction with the silver haloid readily takes place. Since the gelatin is attached to a rigid support it does not swell equally in all directions, effective swelling takes place only in a direction normal to the surface. The amount of swelling will, of course, depend on the salts, etc., present in the developer solution and also on the temperature. Solutions of the ordinary developers are alkaline, and alkalinity increases the swelling of gelatin to such an extent that very undesirable results would accrue were no other substances present to check the swelling. Carbonates and sulphites are present, however, and when present in concentrations greater than 5 per cent. they depress the swelling in the alkaline solution to a value below that which obtains in water. The depressing effect increases rapidly with the concentrations of the salts, a fact which is taken advantage of in preparing developing solutions for use at high temperatures, as in the tropics.

Another method of preventing the swelling which takes place at the high temperatures of the tropics, is to harden the film before development. This may be done, for example, by the use of a formaldehyde solution containing a salt such as sodium citrate, sodium sulphate, sodium phosphate,

Another factor which is influenced by the swelling is the time of fixation. The more swollen the gelatin the more readily does the thiosulphate diffuse into it; also the greater the concentration of the thiosulphate the quicker will be its solvent action on the silver haloid. Increase in concentration of the thiosulphate tends, however, to decrease the swelling of the gelatin, and there will come a point when this decrease more than counterbalances the influence of mass action. There will thus be a minimu mtime of fixation, and this is at a concentration of about 40 per cent. thiosulphate; above and below this concentration, the time of fixation increases.

Swelling also has an influence on the washing of the fixed negative (*cf.* recent papers of *Hickman and Sheppard*). Affecting both the washing and the fixing of the negative is the use of hardening agents, such as potash alum, formaldehyde, etc., in that these have an anti-swelling effect.

Another advantage of gelatin over collodion is that it permits the growth and ripening of crystals. Since the highly sensitive emulsions contain large-sized crystals, it has often been assumed that ripening consists in the growth of large crystals at the expense of smaller ones, according to the Ostwald principle. This is not necessarily the case, since a high-speed emulsion is prepared in a different way from a low-speed emulsion. The increase in size may only be a concomitant factor to the one which produces speed in the grain, that is to say, in the methods used for producing high sensitivity it so happens that increase in size of the grain takes place at the same time as production of speed.

As to what it is which makes gelatin so valuable as a sensitising material, we are still in the dark.

The Solubility of Silver Bromide in Ammonium-Bromide and Gelatin, by CHR. WINTHER, COPENHAGEN.

In some theories of the latent image and development it is assumed that the silver bromide grain of the plate is more soluble in potassium bromide solutions, and especially gelatin, than in pure water. These assertions may not hold for very dilute solutions of potassium bromide, since according to the law of mass action, the silver bromide must be less soluble in the said solutions than in pure water. In concentrated solutions there is the possibility of complex ions being formed, the solubility of silver bromide then being increased in proportion to the concentration of these ions. From Hellwig's measurements the complex ion must have the composition $AgBr^{-8}$, the complexity constant being equal to 1.2×10^6.

I have measured the solubility of silver bromide in solutions of ammonium bromide and of gelatin. In some of the experiments I added known quantities of ammonia, ammonium iodide, ammonium chloride and erythosine.

Experiments.

The investigation was made by measuring the electromotive force of a series of elements of the type:—

$$Ag \left| 0.1\text{-}n\ AgNO_3 \right| \begin{matrix} NH_4NO_3 \\ 10 \text{ per cent. soln} \end{matrix} \left| X \right| Ag$$

where X is a mixture of silver bromide, and of that solution, in which its solubility has to be measured. For each solution two identical elements were measured. The potential π very soon attained a constant value, which remained unaltered for many hours.

The experiments showed that the law of mass action is valid for an excess of bromide of between the limits of concentration used. With one exception, the solubility product obtained had the same value. This was also the case when gelatin, and small amounts of ammonia, erythrosine, ammonium iodide and ammonium chloride were added, using concentrations of these substances of the same order as employed in emulsion making.

When both the ammonium iodide and the ammonium chloride are reckoned as bromide, we get the solubility products which are seen to be of the same magnitude as in the other series.

Thus, the solubility of silver bromide in water is not altered by the addition of gelatin, erythrosine, and small amounts of ammonium iodide or ammonium chloride. By the addition of bromide, the solubility is decreased in accordance with the law of mass action.

Notes on the Photographic Chemistry of Gelatin, by S. E. SHEPPARD, F. A. ELLIOTT and S. S. SWEET.

The properties of gelatin as a protective colloid (largely associated with its viscosity)

are of importance in photographic chemistry—

(*a*) For the formation of the emulsion as a polydisperse system of silver haloid grains.

(*b*) For the inhibition of reduction in absence of exposure, and the regulation of reactions of reduction, etc.

(*c*) In its function as a reversible water swelling hydrogel, permitting free diffusion of crystalloids (salts, etc.).

These functions of gelatin are largely physico-chemical, *i.e.*, they are determined by the equilibrium of the gelatin: water as a function of concentration, temperature, hydrogen ion, etc. *There probably are factors in emulsion making* which have little or nothing to do with these physico-chemical conditions.

While the physical chemistry of the vehicle has much to do with the *structure* of the *emulsion* as an aggregate of grains of various siges, shapes, etc., it has very little to do with the *structure* and *sensitivity* of the grains themselves.

Gelatin Protective Action.—The general character of colloid protective action, as inhibition of precipitation, coagulation, and crystallisation — in short, aggregation changes, is not clear. Although viscosity plays some part, there is evidence that more specific factors are dominant. In the *precipitation of silver haloids in gelatin, it is obviously inviting to connect the protective action* with both the polar character of the silver haloid and of the gelatin.

Results with ash-free gelatin were confirmatory. While the direct solutions show some difference in plasticity (slightly lower) from the diluted ones, in all cases their *mobility was greater.* These differences indicate, like the *difference in gold number* observed by Sheppard and Elliott under similar conditions, a *structure* in the sol which depends to some extent on its mode of preparation.

For the practice of the photographic process, the physical chemistry of the jelly is important. Some evidence, and considerable argument, has been brought in favour of various theories of gelatin jelly structure.

The "skin" effect might explain this. Cortner finds that if jellies of different initial concentration are dried, then ground up, and swollen in water again, that the swelling limit still appears to depend upon the initial concentration. We have made some experiments on the anisotropy of d- -

and swelling of gelatin jellies which bear on this structure problem. Gelatin jellies on rigid supports tend to dry down and swell up normally to the surface. This is not absolute, as shown by stripping, frilling, reticulation troubles. We have tried to compare the relative *contractility* of different gelatins. By *contractility* we mean the relative extent to which a reduction in unit *area* of a drying sheet of gelatin takes place, compared with reduction in *thickness.*

Contraction varies with the origin of the gelatin. The low value for the sizing gelatin, which undoubtedly contained much hydrolysed material, would suggest that this plays a part. *De-ashing* removes the greater part of these. *Persistent* differences exist in gelatins of different origins. That hydrolytic factors do play a part is shown by results with jellies at different initial p_h adjustment.

Anisotropy of Swelling.—Ten per cent. jellies were dried down under identical conditions and stripped from glass. The sheets were then swollen in water, and the *area, weight*, and *thickness* measured. The direct measurements of thickness were not very accurate in this case, owing to the weakness of the jellies, but *volumes* were calculated from the *weights,* using the specific gravities corresponding to each stage.

Figures did not show any unequivocal relation between the contractility and the lateral swelling or expansion. The highest relative expansion is actually given by the poorest grade of gelatin. They point to the existence of individual structural differences in gelatins, depending not simply on actual physico-chemical conditions, but on origin and previous history.

While the total volume swelling diminishes as the concentration of formaldehyde is increased, the lateral swelling is only slightly reduced, on a relative basis of 500 *per cent.* volume increase, the lateral expansion of the formaldehyde treated material appears to be nearly twice that of the untreated, and fairly constant. In these experiments the CH_2O is based on dry weight of gelatin, and was mixed with the solution before coating and drying.

An equilibrium or limited swelling appears to be essential to the Proctor-Wilson-Loeb theory. Swelling reaches a condition of negligible increase in reasonable times, but all factors which decrease swelling tend to make *limited swelling* more apparent, while conversely those which increase

swelling tend to make the swelling *unlimited*. It is obvious that this makes for difficulty in respect of assertions as to "swelling limits." However, most photographically operative solutions tend to discourage rather than encourage swelling, *relative to water at the* same temperature, so that it is possible to obtain some fairly definite evidence on the rate and limits of swelling in these. In our work we have used two methods, one by *weighing*, the other by measuring the *thickness*. The weighing method is only partially satisfactory for solutions. To find the *volume* of jelly from the *weight* it is necessary to know the composition and specific gravity of the solution which has entered the film, and which may vary with the progress of swelling.

With solutions of moderate concentration there is not a great difference between that absorbed and that remaining, and the increase in volume can be calculated.

The Mechanism of the Latent Image Formation, by F. C. Toy, D.Sc., F.Inst.P.

The problem of the reactions which take place in a photographic plate on exposure is of primary importance for knowledge of the complete process. A great advance has been made in the last few years, due to the realisation of the fact that the single silver haloid crystal of an emulsion is the fundamental unit, and a complete theory of the photographic process can only be built up on a knowledge of the behaviour of these individual crystals in relation to exposure.

There is something even more fundamental than the grains themselves, *viz.*, the "centres," the points in the grains from which development starts.

The main facts in regard to the localisation and distribution of the centres are:—

1. They are distributed amongst the grains haphazard.
2. On the average they are distributed equally over the surface of spherical grains, and are concentrated mostly on the edges if the grains are flat plates.

The centres from which development commences are the actual points where the grain has been changed, *and therefore indicate the actual distribution of the material of the latent image*.

There is a controversy as to how these centres are formed. The different views may be summarised as follows:—

1. They are formed in homogeneous grains entirely by the light which is incident at points on the plate in finite discrete quantities.
2. They are pre-existent in the grains before exposure as chemically different substance, the function of the light being to change their condition in such a way that they become capable of acting as reaction centres.
3. A combination of (1) and (2). Heterogeneous radiation incident on grains containing specially light sensitive points.

The recent work of Whittaker is an indication that the reconciliation of these theories may be accomplished at no great distant date.

Exposure Theories, by S. E. Sheppard, A. P. H. Trivelli, and E. P. Wightman.

Exposure theories of photographic developability deal with the quantitative growth of developability with exposure, and with the nature of sensitivity of the photographic material. They may also consider the nature of the latent image.

The salient features of early theories were the assumptions (1) of homogeneity and continuity of the sensitive emulsion, (2) of a like condition of the incident radiation, and (3) of the same for the developed image.

The essential characteristics of later views are, (1) the full recognition of the microscopically and submicroscopically disperse character of the emulsion, and (2) the assumptions (*a*) that the light may be heterogeneous, *i.e.*, radiated and absorbed in discrete quanta; (*b*) that the grains of the emulsion may be inherently heterogeneous as to their sensitivity, and (*c*) that (*a*) and (*b*) may both have to be taken into account.

Absorption of Light and Photocatalysis.

Any formula based on the older theories must be deduced on the further assumption that the rate of change is proportional to the light absorbed by the sensitive material.

Hurter and Driffield postulated: (1) only the energy absorbed by unchanged silver haloid is effective in producing latent image; (2) the absorption coefficient of the changed silver haloid is the same as that of the unchanged. It is difficult to attribute a physical and chemical meaning to this, and, as shown by Ross, leads to a mathematical contradiction.

Equations for rate of photochemical change allowing for photocatalysis have been developed by Plotnikoff, but are too unrelated to experimental facts to be of much assistance. *Before any such mathematical excursions are attempted*, there are other possible assumptions which should be examined.

Newer theories recognise the disperse *character of the emulsion* as fundamental. Thanks to the investigations of Slade and Higson, Svedberg, and others, it is recognised that not only do the grains, although *crystals of one system and class, differ in* size and shape, but they differ in sensitivity.

A grain, however small the exposure, might have its developability changed, that is, its rate of reduction by a *developer increase with exposure. An emulsion of* equal-sized, equally sensitive grains, would then still give gradation under differential exposure, within limits. The less exposed grains would, *for a given stage of development*, give a smaller portion of developed silver than the more exposed.

But from microscopic examination, it appears (1) *generally*, with normal developers and exposures, that a grain which has started to develop becomes entirely reduced, without reference to the exposure, and (2) that a grain is either wholly developable, *or not* at all.

These statements require some qualifica*tions, and a more rigorous experimental* verification. It has not yet been conclusively shown *that the above statements* hold for developers of low reduction potentials, although there are indications that not all of the grains are completely developed in the same way as with high reduction potential developers. Again, it appears that as reduction potential is lowered by bromide, the developability is progressively affected, this influence becoming less *with increasing exposure.*

Not the ultimate size of developed grains is affected by exposure, but the number only.

Sufficient evidence has been brought to show that in many emulsions "clumps" of contiguous grains are formed which develop as a unit when only one grain of the clump is *light-affected*. At the same time, there *are cases of apparent "clumps," not definitely* distinguishable from the others, which do not develop as units.

Since, on the quantum radiation theory, a "clump" may act as a "target" of size equal to its projective area, and since it is not easy to see how a simple nucleus theory of sensitivity, without "quantum radiation," can give the same chance of development to "clumps" as the former theory, the *settlement of this disputed point is of great* importance to exposure theories. The sensitivity of a clump is that of its most sensitive grain, or, according to Svedberg, to the number per unit area of grain. On the for*mer, it is purely a function of the projective* area of the "clump."

Not only does sensitivity of grain increase with area, because of number of nuclei, but *also that nucleus sensitivity increases with* grain size. This is in agreement with emulsion practice.

Results of treatment with CrO_3 and other oxidisers also indicate that the alteration of the *sensitivity by the desensitising agent is* a function of the grain size, *i.e.*, the ratio of percentage developable grains between the treated and the untreated grains is de*creased markedly* with increasing grain size, the smaller grains apparently being much more affected by the desensitising treatment than the larger grains.

It is possible that the average area of the spots ($= \omega$) increases with grain size and that either (1) the spots become more resistant to the chromic acid treatment with their increase in size, or (2) that sufficient time is not allowed to dissolve the large ones, the rate of solution of all the grains being uniform but slow. The latter is hardly likely, since the time is far longer than is required to dissolve any developed silver image where whole grains had been converted to silver. The greater resistance in the case of (1) might be attributed to the position of the spots on the octahedral faces of the larger flat grain, instead of on the cubica lsurfaces of the smaller less flat ones.

The Sensitiveness to Light of Asphalt as Function of its Degree of Dispersion, by Jacques Errera (Brussels).

The name of asphalt is given to a brown-black inflammable and fusible natural mixture. Niépce showed asphalt is sentitive to light.

By successively dissolving asphalt in boiling alcohol, in ether, and by submitting the residue to the action of chloroform, Kayser isolated three components, which he calls, α, β and γ asphalt, to which he assigns different molecular formulæ with a growing percentage of sulphur: $C_{32}H_{40}S$, $C_{64}H_{92}S$,

$C_{32}H_{42}S_2$. γ Asphalt alone is really sensitive to light.

It appears:

1. That the viscosity of the solution of raw asphalt is much less than that of asphalt after treatment, and that, of the two, the one which is obtained by precipitation (Farquhar process) is the more viscous.

2. The molecular weight of raw asphalt is five times as small as that of Kayser asphalt, the latter being about half that of γ asphalt (Farquhar).

3. Submitted to ultrafiltration, the solution of raw asphalt lets through into the ultrafiltrate a much greater quantity of product than the solution of asphalt when treated.

Modern theories seem to admit in sensitive asphalt the existence of three substances chemically defined as α, β and γ asphalt. When studying the question from a colloidal point of view, it would appear more correct to say that asphalt is a "polydispersoid"; the sensitive part is the one which is found in a state of colloidal dispersion. When chemically analysed, this colloidal part proves to be the richest in sulphur, the valences of which being a factor of polymerism. According as their degree of association is greater or smaller we find in asphalt the intermediate stages between molecular and colloidal asphalt. Sunlight seems to have a coagulating action.

Tests of viscosity, molecular weight, dialysis, and sensitiveness to light corroborate this view.

A new process of sensitisation of asphalt was indicated.

Plate Sensitometry, by OLAF BLOCH, F.I.C. (Ilford Research Laboratory).

Considerable advance has been made in plate sensitometry since the time of Hurter and Driffield.

The complete analysis of the quality of an emulsion is a matter of some complexity, and certain points which have arisen in the continuous endeavour to make testing methods more accurate and keep them simple seem of sufficient interest to record.

The so-called speed of a plate is deduced from the straight line portion of the characteristic curve of the emulsion; whilst this is of some value there are many cases (portrait emulsions for instance) when the under exposure curve comprises the most useful portion of the functions of the plate.

To be of value, any system must cover the case of all emulsions and give useful information on contrast giving power, "cut," character of the under exposure portion of the plate curve, nature of the curve in the region of full exposure, behaviour to developers with regard to the production of veil, and some expression giving a reasonable idea of speed. In special cases some knowledge of resolving power and size of grain is also necessary.

Fog.—Fog is a variable so far as the image is concerned, since the greater the exposure the higher the local concentration of soluble bromide produced in development, and the less the fog.

The Gamma Line.—Fairly good curves can be obtained using the H. and D. sector wheel, but exposures are too widely apart for reliable work with many emulsions. Good curves can be obtained by using a wedge.

The following method gives good results. A stencil plate is cut in black cardboard, having four sets of circular openings, five in each set; these openings are of sufficient diameter to cover the field of the photometer, and so arranged that each exposed circle is well surrounded by unexposed plate. A series of timed exposures is given to the plate placed in the dark slide behind the stencil. For fast plates, exposures are made 350 cms. from a standardised lamp, having a small loop filament in one plane. The exposures all fall within the straight line portion of the plate curve. After exposure the backing is removed, and the glass is so cut that each set of exposures is protected against trouble arising from the developer at the edges of the plate. Development is carefully conducted, the dish being regularly rocked in four directions.

For certain emulsions, the gamma lines for varying times of development intersect above the Log E axis. With a view to getting further evidence, ten different emulsions (made by five different manufacturers) were thoroughly tested.

Seven of these had their points of intersection above the Log E axis and comprised 5 rapid and 2 moderate speed plates. Two had points of intersection on the Log E axis, and one (a fast panchromatic) had the point below the Log E axis.

Temperature.—An alteration of the development temperature produces a shift in the gamma slope, and a corresponding change in the speed values as deduced from the straight line portion of the curve. The

densities produced at the higher temperature are uniformly greater than those produced at a lower temperature for the same gamma, but in the under exposure curve the same relationship does not hold good.

The light source, the exposure distance and times, the method of making the exposure ,the composition of the developer and its temperature, the mode and duration of development, the question of fog, the method and apparatus for measuring density, and the mode of expressing the results, all require discussion and standardisation.

The Theory of Photographic Dye Mordanting, by E. R. Bullock, B.Sc.

One of the several methods of converting an ordinary photographic image of gray silver into one of a coloured substance consists in first changing the former into an intermediate image possessing a mordanting character and then treating this with a solution of a basic or acid dye. As with all dye mordanting processes, so dye mordanting in photography has not as yet been found to conform to any simple theory.

The mutual flocculation of the respective colloid particles on mixing two colloidal solutions of opposite electrical character was known to Graham. Biltz (1904) enunciated the rule that colloids carrying opposite charges always precipitate each other if mixed in the proper ratio. On mixing solutions of silver nitrate and potassium bromide, precipitation of the silver and bromide ions takes place not only at the point corresponding to the ratio Ag: Br, but also through a small range on either side owing to adsorption. When a silver iodide hydrosol is added to solutions of methyl violet, precipitation occurs over a wide range, but complete mutual precipitation only over a narrow one.

The solubility of silver cyanide in *N* potassium cyanide solution is greater than that of silver iodide in *N* potassium iodide, this than silver chloride in *N* sodium chloride, and this again than silver sulphide in *N* sodium sulphide. As regards the three last-named silver salts, as ordinarily prepared as images in gelatine by precipitation with an excess of the correspondng potassium or sodium salt, this is the order of their decreasing mordanting power for basic dyes. In order to test silver cyanide, a silver image on film was bleached by immersion in a solution of cyanogen; the resulting image of silver cyanide was found to mordant basic dyes, but owing to the abnormal opacity of the silver cyanide image a direct comparison with silver iodide was not feasible. The sulphides of tin, antimony, and arsenic are readily soluble in sodium sulphide, and are excellent mordants for basic dyes. To show this, the silver image is bleached to silver bromide in a ferricyanide-bromide bath, washed, and immersed in a freshly prepared and very dilute solution of a salt of the type of ammonium thiostannate, etc.

By a series of experiments in which aluminium hydroxide (as an example of a positive colloid mordant) was precipitated in gelatine, and this system then immersed for a sufficient time in solutions of a number of basic and acid dyes, and finally washed in running tap water, it was observed in every case that a basic dye is retained longer by plain gelatine than by gelatine containing aluminium hydroxide than by plain gelatine. The dyes used were acridine orange, brilliant green, capri blue GON, crystal violet O, fuchsine FCOOB, methyl violet, methylene blue B, tannin heliotrope, acid violet 4BS, anthracene blue, complementary red D, Fuchsine S, anthraquinone green, quinoline yellow and tartrazine. On substituting, in a few tests, chrome alum and iron alum for aluminium alum, the same general results were obtained.

The rule of mutual flocculation of colloids of opposite sign is distinctly serviceable as a simple qualitative guiding principle in the study of the subject of the dye mordanting of photographic images.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all *information relating to Patents, Trade Marks*, and Designs can be obtained gratuitously.

Specifications Published this Week.

182084—Soc. Anon des Matieres Colorantes et Produits Chimiques de Saint-Denis, Wahl, A. R., and Lantz ,R.—Manufacture of 2-oxy-l-aryl-naphthylamines.

196431—Wolvekamp, M. E.—Organic mercury derivatives of aurin tricarboxylic acid and their alkali salts.

Abstract Published this Week.

194846—Dyeing cellulose acetate—R. Clavel, Augst, Basle, Switzerland.

Messrs. Rayner & Co. will obtain printed copies *of the* published specifications, and forward on post free for the *price of* 1s. 6d. each.

THE CHEMICAL NEWS,
VOL. CXXVI. No. 3295.

ISOTOPES: RECENT ADVANCES MADE BY DR. F. W. ASTON.

In the current issue of the *Philosophical Magazine* for May, Dr. Aston records officially further results in the mass spectra work on the chemical elements, and some negative experiments are given which are of interest.

One of the most helpful advances has been the use of more sensitive plates termed *Schumannised plates*, because the treatment of the plate is like that of an ordinary one when the gelatine is removed as far as possible, but in plates used by Dr. Aston the dissolving off of the gelatine, by means of dilute sulphuric acid, is not carried so far.

Dealing now with the elements, etc., given in Dr. Aston's paper, the main points are stated below:—

Helium.—At the suggestion of Prof. Mc Lennan, samples of helium from Canadian gas wells were examined for isotopes, but none were observed. In this connection it may be noted that, should there be any He++ atoms present during analysis, these would register themselves on the plates as if their mass was 4.00/2, which lines could be checked against hydrogen lines of mass 2.016. By this test the decimal difference in mass could be accurately determined, but no He++ lines could be found, presumably on account of the high ionisation potential of 80 volts which reduces to a negligible figure their percentage numbers in the mixture.

Nickel.—Sir. J. J. Thomson had employed nickel carbonyl, but in the quantities then used it decomposed, and the metal was deposited on the walls of the discharge tube. Dr. Aston has overcome this difficulty by diluting the nickel carbonyl with carbon dioxide and regulating the dischange current to a safe limit. The chemically determined atomic weight is 58.68. The isotopes recorded were 58 and 60 in such proportions as to give the atomic weight as a mean figure.

Metallic chlorides. — Metallic chlorides are particularly satisfactory to handle in the vapour state owing to their instability, but these have a violent action on rubber and tap grease. The result, apart from undesirable compounds, is the release of free chlorine. Consequently there is a "perfect maze of lines filling every successive unit place and effectually screening any clear vision of the lines of the element under observation." Moreover, chlorine forms hydrogen addition products, chlorine itself having isotopes, 35 and 37, and for every type of combining particle there will be *two* lines for the monochloride, *three* for the dichloride, and *four* for the trichloride, etc.

Titanium.—On account of the foregoing difficulty titanium chloride gave spectra of great complexity and no proper identifications of isotopes could be made. Two promising lines were recorded, but these were identified from previous experiments as being due to tap grease.

Chromyl chloride.—This chloride was "even more hopeless, for its action on tap grease and wax was so rapid as to make it quite unworkable."

Lead ethide and zinc methide.—No lines were recorded with these compounds, the probable reason being the abundant liberation of carbon and hydrogen compounds from the decomposing ethide or methide. As an instance of the delicacy of the method, a single iodine line 127 appeared when using the vapour of zinc methide, which was supposed to be quite pure, being colourless. Dempster's fine work on the isotopes of zinc is referred to.

Xenon, krypton, etc.—This method was successfully used to verify the purity of the xenon from krypton contamination, the sample being one provided by Dr. R. B. Moore, as used in his density determination, thus rendering the density determination free from any criticism on the ground of krypton being present. The value deduced from this determination is 130.2. Dr. Aston considers it a little on the low side, but the mean evaluation in the case of isotopes is not accurate enough to carry weight against a good chemical or density determination. Excellent lines were obtained on the Schumannised plates, and suspected xenon lines 128 and 130 were confirmed.

Dr. Aston here refers to the search for inert gases of higher atomic weight than xenon, and mentions that in this connection two new components of xenon, 124, 126, were discovered.

It will be remembered that Sir J. J. Thomson (*Roy. Soc. Proc.*, 1922, vol. CI., p. 290) found by his positive-ray method two atmospheric constituents of apparent masses 163 and 260, and suggested that these might be due to molecules Kr_2 and and Xe_2.

To make this review up to date and fairly complete, the following abstract from this Journal of May 18, 1923, of Dr. Aston's paper, read before the Royal Society, entitled *A Critical Search for a Heavier Constituent of the Atmosphere by means of the Mass-spectrograph*, is here reproduced:—

"A critical search for a gaseous inert element, heavier than xenon, is described, in which the residues absorbed in charcoal from over 400 tons of air are dealt with.

"The final analysis is made by means of the mass-spectrograph. The result is negative and indicates that such an element certainly does not exist to the extent of 1 part in 10^{15} of air, and probably not to the extent of 1 part in 2×10^{16} parts of air by volume.

"Faint bands observed in the region corresponding to masses 150 and 260 are described and their origin discussed. The first of these is shown to be due to a complex molecule of mercury with a multiple charge, but no conclusion is reached in the case of the other.

"The results of the experiments are not in accordance with the presence of molecular krypton and xenon in the air, recently suggested." See above.

Tin and the whole-number rule.—The earlier work on the isotopes of tin is now confirmed, the values being 116, 117, 118, 119, 120, 121?, 122, 124. The intensities of the lines are such as to render it improbable that any of the lines are due to hydrogen addition products except the value 121, this being very faint on the plate.

In this experiment tin tetramethide was used, which was supplied by Sir W. Pope. The evidence that the above lines were due to tin isotopes is supported by the presence of lines 15, 30 and 45 units higher up in the mass scale by reason of compounds $SnCH_3$, $Sn(CH_3)_2$, and $Sn(CH_3)_3$. These lines show exact whole-number *differences*, but "when compared with other lines on the plate they give values less than whole numbers by 2 to 3 parts in 1,000." The presence of xenon lines and those of tin monomethide amongst them made it possible to compare the registration of the tin lines with them. If the xenon lines, 134, 136, represent whole-number masses, then the compound $Sn^{120}CH_3$ should lie exactly midway if the tin isotope 120 is a whole number, but it is displaced to the left slightly so as to "coalesce partly with Xe^{134}," making this line appear broadened.

Dr. Aston remarks as follows: "It seems impossible to imagine any instrumental defect which could give rise to this shift. There appears therefore to be no escape from the conclusion that tin and xenon cannot both obey the whole-number rule. It was realised and emphasised (*Phil. Mag.*, XXXIX., p. 624) that this rule was not to be expected to hold with mathematical exactness owing to the packing effect, but it is very surprising that elements only differing by three units in atomic number should show so large a divergence. It seems probable that the divergence from the mean (O=16) is greater in the case of tin than in that of xenon, but since the arithmetic sum of the two (supposing them to be of opposite signs) is only about three times the experimental error, satisfactory settlement of this point will have to be deferred till an instrument of higher precision is available."

Iron.—This element gives a volatile carbonyl (prepared by W. H. Mills), and thus makes it possible to obtain a record of this compound on the plate. A strong line was obtained, indicating that an atom of iron existed of mass 56. A fainter line giving a value 54 was also recorded, which may be an isotope, but the line is so weak that iron may be made up entirely of atoms of mass 56, though the chemical atomic weight is 55.84.

Cadmium.—Cadmium, though easily vapourised, gives no lines in the expected region. In this experiment a quartz vessel containing the cadmium was lowered into the cathode-ray path by means of a winch. The metal was vapourised and it condensed on the walls of the tube, forming a bright mirror.

It was noted that mercury was completely eliminated from the discharge by the presence of the cadmium, and it did not reappear "so long as the cadmium mirror remained on the walls of the discharge-tube." A method of eliminating mercury is thus discovered.

Thallium.—As part of the above experiment, this element was tried without results, and it is probable that the cadmium layer removes the thallinm vapour as effectively as it does mercury.

Selenium.—The unsuccessful use of selenium hydride (*Phil. Mag.*, XLII., p. 140) led to the volatilising of the element itself with the result that five strong lines were obtained, viz.: 76, 77, 78, 80, 82. There is a faint line at 74. These values were confirmed by a set of corresponding lines 12 units higher up on the mass scale, due to C Se; also lines 28 units higher, due to COSe, were obtained, and some faint lines of CSe_2 were identified. It is to be noted that three selenium isotopes have the same masses as some of those of krypton. This is a case of isobaric heterotopes.

Tellurium and beryllium.—Pure tellurium was volatilised, yet no lines were obtained, but this failure is probably due to its high boiling point and consequent low vapour pressure. Tellurium chloride was used without success.

Beryllium acetate was tried, but its immediate decomposition yielding a white oxide prevented this experiment becoming successful. G. P. Thomson's positive ray analysis of this element, however, stands, there being only one value, 9, which is in close agreement with Hönigschmid and Birckenbach's value, 9.018.

Aluminium.—The chemical atomic weight of this element is now known to be 26.96, and it is therefore evident that in all probability it is a simple element having only one mass value, 27. Dr. Aston remarks that as a rule odd atomic-weight elements have never more than two isotopes, and the occasional appearance of the line 13.5 is probably due to Al^{++} from the electrodes. The line 27 has, however, been observed. Lines 62 and 97, also recorded, indicate mono- and dichlorides of bodies of masses 27 and 28. The latter may be Si^{28} or CO, but the former is probably aluminium, and Dr. Aston says "it is therefore reasonably certain that this element consists mainly of atoms of mass 27, and since there is no evidence of atoms of lighter mass, the chemical atomic weight leads definitely to the conclusion that it is simple."

Chlorine.—In the foregoing experiments exceedingly intense lines, 35, 36, 37, 38, have been obtained, but no trace of a line at 39, and Dr. Aston concludes that the hypothetical isotope 39 does not exist.

Antimony.—Antimony hydride proved of no use, but antimony methide, prepared by Prof. G. T. Morgan, when introduced with CO_2, gave values 121 and 123. With sufficient exposure similar lines appear 15 and 30 units higher up on the mass scale due to the mono- and dimethide respectively. Faint companion lines, 122 and 124, appear to be due to hydrides from their irregular intensities. The antimony isotopes seem to be in accord with the whole-number rule. The atomic weight as determined by Willard and McAlpine is 121.77, which agrees with the mean estimate of the above isotopes, judging from the relative intensities of the lines.

Table of Isotopes.

Dr. Aston gives the table of isotopes as appeared in this Journal March 9, 1923, and he proposes to call the integers *mass-numbers*, as it is evident from the foregoing that there are some cases where the deviation from whole numbers, though small, is still appreciable. The mass numbers are given in the order of the intensity of the mass lines, and numbers in brackets are provisional.

Supplementary Notes.

Those wishing to study the literature exclusively devoted to the non-radioactive isotopes from the experimental (discovery) point of view should consult the following literature:—

Aston: *Nature*—Nov. 27, 1919; Dec. 18, 1919; Mar. 4, 1920; July 1, 1920; Dec. 9, 1920; Mar. 17, 1921; June 23, 1921; Sept. 2, 1922; June 24, 1922; Nov. 18, 1922; Dec. 2, 1922; June 2, 1923.

Aston and Thomson: *Nature*—Feb. 24, 1921.

Aston: *Philosophical Magazine*—April, 1920; May, 1920; Nov., 1920; July, 1921; Sept., 1921; May, 1923.

G. P. Thomson: *Philosophical Magazine*—Nov., 1921.

Dempster: *Science*—April 15, 1921; Dec. 10, 1921.

Dempster: *Physical Review*—Dec., 1921; March, 1922; Dec., 1922.

The basic discovery that stimulated research in connection with isotopes of the non-radioactive class was made by Sir J. J. Thomson when he revealed the duality of neon. See his book, "Rays of Positive Electricity," 1913, or later edition.

The above list may be extended to include experiments made to separate isotopes, their classification, those belonging to the radio-active class, theoretical views, etc.

Announcements of the discoveries appear in *Nature* and *Science*. For fuller accounts see *Philosophical Magazine* and *Physical Review*, as listed above.

A NOTE ON KAFFIR MELON OIL.

Analyses of Seeds.

By Chas. F. Juritz, M.A., D.Sc., F.R.S.E., F.R.S.(S.Af.), F.I.C.

In *Science Bulletin* No. 6 of the Department of Agriculture, I tabulated thirty-eight analyses o fthe ring, seed, and pulp of the two well-known varieties of kaffir melon (Tsamma and Monketaan), made, in the latter case, at different stages of ripening, and also gave a brief description of the melons and their adaptability as stock-food. Only one analysis of tsamma seed was made, and in that case the yield of fat or oil from the fresh seed was 4.64 per cent., the corresponding oil-content of fresh monketaan seed ranging (according to eight analyses) from 20.25 per cent. to 23.10 per cent.

The analyses above referred to were shortly summarised by Professor M. Rindl in the course of his article on "Vegetable Oils and Fats" in the December, 1920, issue of the *South African Journal of Industries.*

The tsamma analysed eight years ago had grown in the Vryburg district, and the monketaans in the Cape Peninsula. Early in 1920 I procured, through the Magistrate of Kuruman, supplies of tsamma and monketaan seed from the vicinity of the Kalahari Desert.

These seeds (without further drying) were analysed, with the following results:—

	Tsamma Seed. Per cent.	Monketaan Seed. Per cent.
Water	6.57	7.04
Oil	12.85	22.10

The oils, which were of a pale-yellow colour, were extracted by means of ether, and showed the following constants:

	Tsamma Seed Oil.	Monketaan Seed Oil.
Specific gravity at 15.5° C.	0.917	0.930
Refractive index at 40° C.	1.4684	1.4669
Iodine value	131.5	118.8
Saponification value	161.1	187.9
Acid value	1.8	5.8

The iodine value of an oil indicates the mount of oxygen the oil is capable of absorbing from the air, and therefore of drying to a solid elastic film when exposed to the air in thin layers. A good drying vegetable oil usually shows an iodine value between 120 and 200, whereas the iodine value of a semi-drying oil lies between 100 and 120, and that of a non-drying oil between 80 and 100. The monketaan oil examined seems to be near the border line, but the tsamma oil is well within the region of the drying oils. The iodine value of linseed oil, however, is much higher, and varies from 175 to 200. Tsamma oil, in this respect, more nearly resembles sunflower oil (with an iodine value of about 130) and soya bean oil (with a range between 126 and 135).

The saponifiction value of an oil is an index of the proportion of alkali needed to convert a certain quantity of the oil into soap: hence it indicates the amount of the particular oil which, when treated with alkali, would be required in order to produce a definite quantity of soap. Waxes, which are not capable of yielding soap, have relatively low saponification values, which rarely rise above 140. Lard and tallow, on the other hand, approximate to 200 in their saponification values, while butter-fat exceeds 220. The tsamma oil shows one of the lowest saponification values in the records of vegetable oils, but the monketaan oil is closer to the usual average of this type of oil.

The acid value shows the proportion of free acids in an oil, and is subject to considerable variation in which the age and quality of the oil often play a great part. A high acid value is objectionable in an oil in many ways: if the oil is intended for edible purposes, the presence of much free acid produces a sharp unpleasant flavour; it lowers the oil's potential yield of glycerine; it imparts corrosive qualities to the oil as a lubricant; the free acid tends to cause blocking of oil-ducts by crystallising; and in medicinal and pharmaceutical preparations its action on skin and mucous membrane is of an irritant nature. In neither case quoted above is there any objection against the melon oil.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, MAY 31.

Papers read :—

E. GRIFFITHS, D.Sc., and G. W. C. KAYE, D.Sc. *The Measurement of Thermal Conductivity, No.* 1. Communicated by Sir Joseph Petavel, F.R.S.

Among the points dealt with in the paper were the thermal resistance at the bounding faces of a material, the effect of superimposing layers of compressible material, the measurement of the thickness of compressible material, the dependence of the conductivity of timber on structure and moisture-content, the variation of the conductivity of rubber with mineral content.

G. W. C. KAYE, D.Sc., and J. K. ROBERTS, Ph.D. *The Thermal Conductivities of Metal Crystals. I.—Bismuth.* Communicated by Sir Joseph Petavel, F.R.S.

Previously all accurate measurements of the thermal conductivity of metals have been made on bars of heterogeneous structure. It was thought desirable to compare the values so obtained with the more fundamental ones given by single crystals.

A " plate " apparatus has been developed which makes it possible to measure thermal conductivities as high as 0.02 c.g.s. with an accuracy of about 1 per cent., using specimens 2 cms. by 1 cm. in area and about 1 or 2 mm. in thickness.

The thermal conductivities of single crystals of metallic bismuth have been determined in directions parallel and perpendicular to the trigonal axis. The values found at 18° C. are, in c.g.s. units :—

Thermal conductivity of bismuth parallel to trigonal axis ... =0.0159
Thermal conductivity of bismuth perpendicular to trigonal axis =0.0221
Ratio of conductivities ... ... =1.39

The mean value 0.0191 agrees well with the figure 0.0193 obtained on bars by Jaeger and Diesselhorst in 1899.

This agreement indicates that in the case of bismuth metal in the aggregate, the distribution of the constituent small crystals is random, and that the effect on the thermal conductivity of such inter-crystalline layers as may be present is not appreciable. It is hoped to carry out experiments on other metal crystals to see whether this result is generally true.

C. V. DRYSDALE and S. BUTTERWORTH. *The Distribution of the Magnetic Field and Return Current Round a Submarine Cable carrying Alternating Current.* Communicated by F. E. Smith, F.R.S.

PART I. (By C. V. DRYSDALE.)

The experimental results obtained confirm the values of the velocity of propagation and attenuation derived from theory, and the field distribution above the surface agrees very fairly with the theory of Mr. Butterworth derived from consideration of the water as a conducting lamina.

PART II. (By S. BUTTERWORTH.)

Expressions for the distribution of electric force due to a long cable carrying alternating currents and immersed in a sea of uniform depth have been obtained in the form of Fourier integrals. From these integrals formulæ have been developed which cover the following cases :—

(1) The field above the surface of the sea when the depth of the water is small.
(2) The field above the sea at large distances from the cable, there being no restriction in regard to depth.
(3) The field below the surface of the sea for points vertically above the cable.
(4) The field below the surface of the sea at large distances from the cable when the depth of the sea is great.

SIDNEY RUSS, D.Sc. *The Effect of X-rays of Different Wave-Lengths upon Some Animal Tissues.* Communicated by Prof. A. W. Porter, F.R.S.

The experiments recorded were designed to find whether a differential action exists when X-rays of different wave-lengths act upon animal tissues. Two regions in the X-ray spectrum were selected, and it was arranged that equal doses of X-ray energy were absorbed in their passage through the tissues. It was found that under these circumstances more profound effects were produced by the longer wave-lengths (0.45 to 0.30 A.U.) than by the shorter wavelengths (about 0.168 A.U.), both upon the normal skin of the rat and upon Jensen's rat sarcoma. The degree of this differential action is more pronounced in the case

of the skin than it is for the tumour, the numerical values being 6 and 2.6 respectively. It is proposed that these numbers be termed "therapeutic factors," and the bearing they have in radio-therapeutics is discussed.

Papers read in title only:—

E. F. ARMSTRONG, F.R.S., and T. P. HILDITCH, D.Sc. *A Study of Catalytic Actions at Solid Surfaces. Part XI.—The Action of Alumina and Certain Other Oxides in Promoting the Activity of Nickel Catalyst.*

In the absence of any carrier for the nickel, the presence of a small proportion (up to 5 per cent.) of an oxide, such as that of aluminium or magnesium, etc., causes considerable increase in the catalytic activity of the reduced metal, the mixed oxides being prepared by precipitation from a solution of the corresponding mixed salts.

When the nickel oxide is deposited on a support, the behaviour is different. Thus kieselguhr, from which the metallic constituents have been extracted, gives a nickel catalyst inferior to that on natural kieselguhr. The activity of the resulting catalyst is restored if alumina to the extent of about 20 per cent. of the nickel is precipitated with the hydroxide of the latter, whereas a proportion of alumina equal to that of the nickel depresses the catalytic activity of the product again. If, however, the latter proportion of alumina is first deposited on the acid-extracted kieselguhr and the nickel hydroxide or carbonate then precipitated on to this preparation, the catalytic activity of the product generally exceeds that of nickel on the natural kieselguhr.

All these observations are explicable on the hypothesis that the action of the non-reducible oxide is mainly mechanical and connected with increase or diminution of the surface area of the exposed nickel.

We have not been able to effect more hydrogenation with a given weight of reduced nickel in presence of these oxides than with the same weight of nickel deposited in the ordinary way on a suitable support offering a maximum of surface, and accordingly we believe that the "promoter" effect observed is simply due to their influence on the available surface of the reduced nickel.

N. K. ADAM. *The Structure of Thin Films. Part IV.—Benzene Derivatives.—A Condition of Stability in Monomolecular Films.* Communicated by W. B. Hardy, Sec. R.S.

1. Derivatives of benzene, such as hexadecyl phenol, containing one long chain and one polar group in the parå position, orient on water surfaces like fatty acids, the phenol group forming the head of the molecule in contact with the water. Measurements of the cross-section of the head by the method of Part II. of these papers gave a result in good agreement with the corresponding cross-section of the nuclei of aromatic compounds, deduced from Bragg's measurements on crystals. The relation between the films on water and the monomolecular layer, which would be obtained by repeated cleavage of the crystal, is explained.

2. Films of these compounds show the usual phenomena of expansion to a two-dimensional vapour, described in Part III.

3. Compounds such as cetyl palmitate, palmitic anilide, etc., which contain one polar group placed between two chains or one chain and a ring, do not adhere to a water surface well enough to give measurable condensed films, though in the expanded state such films are often more stable.

4. The para sulphonic acids in hexadecyl and octadecyl benzene give soap-like solutions in water.

N. K. ADAM. *The Structure of Thin Films. Part V.* Communicated by W. B. Hardy, Sec. R.S.

1. Bromine in the α position in the bromo-acids and esters, increases the cross-section of the molecules in the films. The heads of bromo-acids may pack in several different arrangements, having areas from 32.8 A.U. to 26 A.U.

2. The bromine atom increases the solubility of films of the higher fatty acids. It also lowers the temperature of change from condensed to expanded films; but it does not appreciably affect the properties of the films when expanded.

3. The double linkage in the α β position relative to the $COOC_2H_5$ group increases the cross-section of the molecule in the films, as it does in iso-oleic acid.

4. The transition betwen two forms of condensed film, such as those found with the substituted areas, seems exactly ana-

logous to that between two polymorphs or allotropic modifications of solid substances.

5. The law found in Part III., giving the increase of the temperature of expansion of the films with increasing length of the hydrocarbon chains, has been confirmed on eight homologous series.

W. B. Rimmer. *The Spectrum of Ammonia.* Communicated by Prof. A. Fowler, F.R.S.

Of the three bands which are associated with the spectrum of ammonia, the ultra-violet band has already been investigated in detail by Fowler and Gregory, and has been found to be represented in the solar spectrum. In the present investigation attention has been specially directed to the "Schuster bands," λ 5635 and λ 5670, and the "α band" of Eder and Valenta.

The Schuster bands have given no sign of resolution under high dispersion, and it is probable that they do not occur in the solar spectrum. The α band is of great complexity, consisting of about 3,000 lines, of which many of the brightest have been measured with sufficient accuracy for proper comparison with the solar spectrum; there is, however, no conclusive evidence that this band occurs either in the solar spectrum or in the spectrum of sunspots.

Observations under a variety of experimental conditions are in accordance with previous conclusions that the Schuster bands have their origin in the normal ammonia molecule; while the ultra-violet band is probably due to emission from a more stable combination of nitrogen and hydrogen. In addition, it is concluded that the band is associated with a combination of nitrogen and hydrogen of intermediate stability.

The occurrence of the ultra-violet band alone in the solar spectrum thus indicates that only the most stable combination of nitrogen and hydrogen can exist under the conditions that obtain in the reversing layer.

ROYAL SOCIETY OF ARTS.

A lecture was given before the Dominions and Colonies Section, on Tuesday, June 5, entitled *The Economic Conference and the Colonies*, by Sir Edward Davson. His Grace the Duke of Devonshire, K.G., G.C.M.G., G.C.V.O., P.C., Secretary of State for the Colonies, presided.

THE FARADAY SOCIETY.

General Discussion on the Physical Chemistry of the Photographic Process.

At the meetings on May 28.

(*Continued from Page 352.*)

The Theory of Photography, by Wilder D. Bancroft (Cornell University, U.S.A.).

The three fundamental things in photography are Emulsion, Latent Image, and Development. The question of the latent image may be considered as almost settled. I present to-day a theory of development. The theory of the emulsion is still very much up in the air in spite of the work done in the last few years.

The Emulsion.

The photographic emulsion consists essentially of silver bromide dispersed in gelatine and usually submitted to a ripening process to increase its sensitiveness. Fast plates contain some silver iodide, and slow plates silver chloride. The question of ripening involves what Svedberg called plate-sensitiveness, and was studied by Hurter and Driffield. Since the conditions of emulsion making are kept secret by the makers, the development of a theory of emulsion making has been slow, and it is extremely probable that present emulsions are nothing like as good as they would have been, had the problem been one which could have been studied by more people.

Plate Sensitiveness.—The ripening of an emulsion involves the dissolving and reprecipitation of silver bromide. It has been generally believed that a coarse grain is more sensitive than a fine one, but this is not always necessarily true. At present it is generally admitted that there is no necessary connection between size of grain and speed, although under apparently similar conditions the plate with the coarser grains is usually faster. Sensitiveness is due to differences in structure or composition of silver bromide grains. The smallest grains of the bromide are definitely crystalline and have the same structure as the larger ones, the crystalline form being a cubic lattice. Trivelli and Sheppard have shown that silver bromide crystals belong in the dyakis-dodecahedral class and there is no sufficient reason for assuming the existence at an ordinary temperatures of a stable or metastable bromide.

Ripening is not due to a reduction, to a series of allotropic modifications, or to a coarsening of the grain as such. That eliminates changes in the composition of the silver bromide itself, changes in the chemical state of the silver bromide, and changes in the physical state of the silver bromide alone, which leaves us facing a blank wall if we postulate that the effective grain is pure silver bromide. The only apparent way out of the difficulty is to postulate that the silver bromide grain is a complex of silver bromide, gelatine, and water, and that ripening consists in an unspecified change in the relative proportions of these three. Since this was written, Reinders has shown that silver chloride crystals contain gelatine when they separate from an ammoniacal solution of silver chloride to which gelatine has been added. While it is probable that silver bromide behaves in the same way, this seems to have been assumed rather than to have been shown experimentally. Recent work on catalysis shows that adsorption and catalytic activity vary enormously with the structure of the surface, and perhaps we are dealing with gelatine adsorbed at the surface of silver bromide crystals and not entangled in the space lattice. If the action of the gelatine is solely on the surface, it should be possible to make a fast plate by precipitating silver bromide under suitable conditions from an aqueous solution and emulsifying the crystals in gelatine.

It is possible to obtain a much faster plate with gelatine than with dry collodion.

Grain Sensitiveness.—It is admitted that the silver bromide grain is the unit, though the group of grains may act as a single grain. We should thus expect to get the same blackening on prolonged development for widely varying exposures, which is not so. The following hypotheses may be made to account for this:—

1. The incident light may not be homogeneous.
2. The opacity of the silver may vary with the exposure.
3. The grains in an emulsion may vary in sensitiveness.

Silberstein, who starts from Einstein's hypothesis that "light does not consist in a continuous distribution of energy, as in the classical theory, but is entirely split up into light quanta or discrete parcels of very concentrated monochromatic light, each parcel containing a quantum of energy," considers that the bromide grains are bombarded by light-darts and that a grain is made developable only when the axis of the dart hits it in a point not too near the edge.

The bombardment, without the conception of darts, had been suggested previously by Lowry. But Clark has made attempts to see whether the development of silver haloid grains after treatment with sodium arsenite proceeded in the same way as when light is used, or X-rays, for making the plate developable. Single-layer plates were prepared from a commercial ultra-rapid plate in the manner described by Slade and Higson. The grains in the emulsion were mostly flat plates. The emulsion used was the same as that employed by Toy. The plate obtained as described was examined in the microscope. A few of the grains were observed to be changed completely; but the majority showed centres exactly similar in appearance to those obtained by Toy when exposure is to light. These results indicate that the reduction centres are an essential part of the grain structure, and that they exist in the grains from the time the emulsion is made.

We are forced to conclude, Mees pointed out (in 1915), that grains in an emulsion are of many sizes, and both the sensitiveness and plate curve depend on the distribution of the different sizes of grains. Svedberg showed later that with grains of the same size, the same type of curve is obtained as with grains of assorted sizes. We may look upon each grain as either entirely developable or not developable at all. The behaviour of a haloid grain towards a developer should vary with exposure in a discontinuous way; when the exposure has reached a certain minimum limit the grain becomes developable and remains so until the exposure has reached a maximum limit —solarisation—when the grain suddenly loses its reducibility.

Svedberg (1922) stated that the substance of the latent image in the haloid grain consists of small centres distributed through it or its light-affected part, and these centres are distributed by chance.

Later, Svedberg stated that a statistical study of the distribution of the centres showed that within each size-class of grain they were distributed according to chance.

In the emulsion with nearly spherical grains, of narrow range of sizes, mutual infection occurs little if at all; while in emulsions with a wide range of grain sizes and having many large polyhedral tablets, mutual infection plays a large rôle in deter-

cining the "speed" and the density per unit exposure increment. The result is evidently of capital importance for the theory of sensitivity and exposure; for whether the high correlation of grain size with effective sensitivity is due to a discrete structure of radiation, or to a pre-existing change distribution of sensitising nuclei amongst grains, it is evident that the extension of the definition of grain size to clumps, the existence of *mutual infection*, is of basic importance for photographic theory.

Latent Image.

Owing to the very slight change in silver bromide on short exposure, it has always been popular to assume that the latent image is a physical or allotropic modification. Namias assumed polymerisation, Hurter and Driffield depolymerisation, Bredig mechanical disintegration, Chapman Jones labile form, and Bose a mechanical strain. All these assumptions, and the further one of von Tugolessow that the latent image is an oxidation product, fail, since all the phenomena of the latent image can be duplicated by immersing the plate in a solution of a weak-reducing agent, such as sodium arsenite. This proves that the latent image is a reduction product of silver bromide. It cannot be a single, definite subhaloid because no such compound has been prepared. No satisfactory chemical reactions can be assigned to it, and the prolonged action of light does not yield the pure compound, and this hypothesis cannot be reconciled with the facts of solarisation.

Trivelli at one time postulated the existence of green Ag^8Br^7, blue Ag^8Br^6, yellow Ag^8Br^5, and red Ag^8Br^4; but he probably does not believe in them now.

The latent image cannot be free metallic silver (nucleus theory), as it does not show the reactions of free silver, and because the hypothesis cannot be reconciled with solarisation.

It is due to silver adsorbed by the bromide because it can be prepared synthetically. It behaves like a phase of continuously varying composition. This hypothesis also accounts for all the chemical reactions of the latent image, and for the facts of solarisation.

The Developer.

The theory usually held regarding development of the latent image is that the developer is a reducing agent sufficiently powerful to reduce exposed silver bromide and yet not powerful enough to reduce unexposed silver bromide.

A theory of photographic development must account for the following:

1. A developer must be a fairly strong reducing agent, and yet it is apparently impossible to produce a satisfactory negative with *stannous chloride*, *m-aminophenol*, formaldehyde, or gallic acid.

2. There is no appreciable difference between the electromotive forces of unexposed silver bromide and of that which has received a short exposure.

3. All developers develop gelatine free silver bromide readily even though the silver bromide has not been exposed to light.

4. Most developers give negatives after very short exposures and positives after very long ones.

5. Some developers give positives with very short exposures.

6. With any one developer the exposure necessary to cause a change from negative to positive varies with varying concentration of the developer.

7. Very dilute developers act like light and decompose silver bromide without developing it.

8. Some developers work rapidly and others slowly; the difference is not always one of reducing power as measured by electromotive force, though this is unquestionably a factor.

9. Bromide is very effective with some developers and less so with others.

The fact that we get a negative with one developer and a positive with another shows that the potentials of exposed and unexposed silver bromides are not the sole factors. Developers must therefore have other functions than those of reducing agents of varying strengths. The simplest assumption seems to be that we have selective adsorption and thereby markedly varying concentration at the surfaces of the silver bromide grains. If the reducing agent is adsorbed much more strongly by exposed silver bromide than by unexposed silver bromide, the former will develop more rapidly than the latter and we shall get a negative. If the reducing agent is adsorbed more strongly by the unexposed silver bromide than by the exposed silver bromide we shall get a positive. By the adsorption theory we are thus able to predict the possible existence of the three types of fairly strong reducing agents that we actually encounter; but that does not necessarily mean

that the developers really behave in this way. Until some independent proof is furnished, the theory remains an assumption.

In 1913 I discussed the theory of the developer exclusively from the point of view of selective peptisation. I have now laid stress on selective adsorption with selective peptisation as a resultant phenomenon, partly because it seems to me a better way of presenting the subject, but also because Dr. Sheppard tells me that this way of presenting the matter will meet with less opposition from those who know about photography.

The Most Important Adsorption Reactions in the Photographic Film, by DR. LUPPO-CRAMER (SCHWEINFURT IN BAYERN).

Adsorption Phenomena of Silver Haloids.

Primary consideration should be given to the latent image, but I shall confine my attention to *Optical Sensitising and Desensitising*.

In 1873 Vogel discovered the method of optical sensitisation by means of dye-stuffs, and it is usual to date the invention of orthochromatic photography from that year. But, immediately after the discovery of the Daguerreotype process, phenomena were observed, which undoubtedly depend on a quite analogous sensitisation, described first in 1840 by E. Becquerel on the "action excitatrice, continuatrice et destructive" of light rays. It was observed that the latent image could be made directly visible on a Daguerreotype plate by yellow, green and red light rays, and also that an underexposed image could be intensified by subsequent development in mercury vapour, if the image before development were further exposed under a yellow or red glass. In these cases the colloidal silver formed in the silver iodide by the first exposure is an optical sensitiser. In fact, finely divided silver is like an organic dye; it dyes wool and silk, and can be used exactly like a dye to colour silver haloids, so that Eder, as a result of spectral analytical investigations of photochloride and photobromide gelatin films, which I had prepared, concluded that colloidal silver is an ideal panchromatic sensitiser.

Dyeing of silver haloid by silver and dye-stuffs is in both cases a characteristic absorption process. Shortly after H. W. Vogel's discovery, it was found that silver optically sensitised, but that this was not chloride and silver bromide could be easily the case with silver iodide, which remained practically indifferent. This is remarkable, since silver iodide can be easily dyed. This tendency for adsorbing dyes, depends less on the chemical nature of this silver haloid than on the fact that silver iodide has a colloidal gel structure, and takes up dye more easily than the bromide or a highly sensitive plate, which from ripening grows into the form of more or less compact large crystals.

Numerous dye-stuffs also act as chemical sensitisers, increasing the total sensitivity towards white light.

The sensitivity of silver bromide is diminished by certain dye-stuffs. It is possible to develop even panchromatic plates in the unscreened light of a candle. Safranines are especially suitable for this, and there I have called it the Safranine Process. Recently E. König and R. Schuloff have introduced the pinakryptols, pinakryptol green being especially good.

Dyeing by desensitisers does not appear to differ from that with sensitisers. Desensitising appears to depend on the oxidising action (by reason of chemical constitution) exerted on nascent silver.

The strongest sensitisers of the cyanine group also act as desensitisers if bromine salts are present to support the tendency of regression of the silver bromide.

It is especially noteworthy that basic dye-stuffs coagulate a mixture of the sols of silver bromide and silver with the formation of photobromide.

Adsorption Phenomena with Silver.

Both silver sols and also gels resulting from them by coagulation adsorb many substances. The black silver of the photographic negative also shows a strong adsorptive power for many substances, including thiosulphate. If normally developed negatives are hardened with chrome alum before fixation, and then fixed in concentrated bromide, it is possible to obtain the silver free from adsorbed substances. If such a negative is now bathed in thiosulphate, washed, and then the silver dissolved in chromic acid, nitric acid, or persulphate, a residue of silver sulphide remains.

Adsorption of thiosulphate by silver is really the cause of the peculiar reducing action of persulphate. In the lesser exposed parts, the silver is more finely divided than in the high lights, which are more quickly attacked by the persulphate.

SOCIETY OF GLASS TECHNOLOGY.

The sixty-second meeting of the Society was held in University College, London, on May 16. The President, Prof. W. E. S. Turner, D.Sc., occupied the chair.

At the first session two papers were presented. The first was entitled "*On the Refractive Index Changes in Optical Glass Occasioned by Chilling and Tempering,*" by F. TWYMAN, F.Inst.P., and F. SIMEONS, B.Sc., F.Inst.P. Mr. Simeon defined "Chilling" as the rapid cooling from a high temperature, as opposed to the controlled cooling from a medium temperature known as "annealing." Considerable "chilling" could be effected by allowing glass to cool in air from a temperature within or above the annealing range. The process of tempering a metal consisted in the removal of a part of the properties introduced in the preceding operation by heating it to a definite temperature considerably lower than that attained for "chilling," and allowing it to cool slowly. The term "tempering" was applied to the analogous partial recovery of the properties of glass in the annealed state on heating. "Annealin~ temperature" was defined as the temperature at which internal stresses existing in a glass were reduced to one-twentieth their original amount in 0.26 min.

The effect of chilling dense barium crown and borosilicate crown glasses might be to lower the refractive index by as much as 0.004 and 0.0013 respectively. This lowering was removable by heating to a temperature and for a time which had been ascertained in certain cases. A want of homogeneity could be produced by moulding, owing to surface chilling, which required for its removal a longer maintenance at the high temperature than would suffice to remove elastic stress from a homogeneous sample.

MR. V. STOTT, B.A., F.Inst.P., gave a paper entitled "*Notes on Burettes,*" in which he gave details of measurements of the amounts of liquids run from burettes under various conditions. A burette which empties rapidly has a high drainage factor, and the draining from the walls continues over a very long period. In fact, in a 50-c.c. burette emptying in 20 sec., the drainage was not complete in 30 minutes. On the other hand, a burette which has a long emptying time, has a small drainage, which is practically complete after a short time. Accurate readings can be obtained much more quickly by using a long emptying time and a short drainage than by using a short emptying time and a correspondingly longer drainage time.

The errors occurring through using a burette calibrated for a certain delivery time with a jet which gave different delivery time were dealt with, and in specified instances it was shown that such errors were too large to be negligible.

At the second session the President referred to the death of Sir Albert J. Hobson, one of the first members of the Society. He also intimated that the visit to Paris which had been postponed would take place some time in July.

Two papers were presented. (1) "*A New Method of Glass Melting,*" by A. FERGUSON.

This method claimed to melt and refine tank bottle glasses with 30 tons of coal to 100 tons of glass, including a 60 per cent. margin of safety. The process consisted of a cone or column of whirling gases at 1,800° C., into the vortex of which batch ground to a 60-mesh standard was dribbled at the rate of two pounds per second, the carbon dioxide of the limespar and soda having been first driven off in a preheater, so that the work of the furnace was only to raise the temperature from 850° to 1,350°. The particles of finely-divided batch exposed to the heat in a surface which was over 6,000 times that of batch "spread on," and the permeation of the particles was 2,000 times easier. All reactions necessary to form glass molecules took place in a gas at least two million times less viscous than tank metal, so that affinities could reach each other, collide and react millions of times per second, instead of all the energy of the atom being required for hours to find the waiting affinity lurking somewhere in a tank, and when not encountered resulting in seed, striae and unequal strain in the glass. All preheating was done by waste heat after the duty of the heat had been carried out. The coal was retorted, the hydrocarbons saved, air and batch preheated and freed from carbon dioxide (which was later converted into carbon monoxide in the producer). The process was entirely automatic. The batch, instantly melted and refined, flowed through a stream line tank to a periphery gatherer in a fire-hearth.

(2) "*Natural Sillimanite as a Glass Refractory,*" by S. ENGLISH, M.Sc. Results of tests showed that this material possessed properties of value to glass makers. Test pieces were made up by mixing 100 parts of sieved sillimanite with 10 parts of finely-ground clay; such mixture could be made into slabs and pressed into crucibles. These slabs and crucibles were examined for the properties which are the chief causes of trouble to glass makers when using ordinary clay refractories, and the results showed: (I.) The drying and firing shrinkages of the sillimanite mixture were very much less than the corresponding contractions of pot clay mixtures; in fact, when the sillimanite slabs were completely air dried they showed practically no further shrinkage on firing to 1,400°. (II.) The porosity of the fired sillimanite slabs was rather less than the porosity of pot clay slabs fired to the same temperature. (III.) Sillimanite crucibles were attacked much less by molten glass at 1,400-1,420° C. than were similar sizes pot clay crucibles. The attack was measured by determining the iron oxide and alumina content of two glasses and remelting each of them for 6 hours at 1,400-1,420° C. in sillimanite and in clay crucibles. The iron oxide and alumina contents were again determined, and comparisons showed that in each case the clay crucibles were attacked three times as rapidly as the sillimanite crucibles.

The Annual Dinner of the Society was held in the Hotel Cecil. The President was in the chair. Among those present were Sir F. W. Dyson, F.R.S., Astronomer Royal and President of the Optical Society; Sir Lawrence Weaver, K.B.E., Director, United Kingdom Exhibits, British Empire Exhibition (1924); H. J. C. Johnston, Esq., President of the Institute of Clayworkers; Frank Wood, C.B.E., B.Sc., and Dr. M. W. Travers, F.R.D., Past-Presidents of the Society; A. R. Upjohn, Esq., LL.B., Master of the Glaziers Company; R. L. Frink, Director of the Glass Research Association; Mons. Courty, Paris; J. Connolly (Hon. Treasurer); S. English (Hon Secretary); and others.

The following day a party from the Society had the privilege of visiting the new works of Messrs. James Powell & Sons (Whitefriars), Ltd., at Harrow.

THE OPTICAL SOCIETY.

VISIT TO ROYAL OBSERVATORY.

By the courtesy of the Astronomer Royal, a visit has been arranged to the Royal Observatory, Greenwich, on Saturday, June 9, 1923, at 3 p.m. Fellows and Members desirous of availing themselves of the opportunity of visiting the Observatory on this date are requested to send their names to the Honorary (Business) Secretary of the Society at the Imperial College, not later than Thursday, June 7.

ORDINARY MEETING.

A meeting of the Society will be held at the Imperial College, Imperial Institute Road, South Kensington, at 7.30 p.m., on Thursday, June 14, 1923, when the following papers will be presented and discussed:—

Levels and level Bubbles, by S. G. STARLING, A.R.C.Sc., B.Sc., F.INST.P.

A new form of Balloon Theodolite, by T. F. CONNOLLY, M.Sc.

The Primary and Secondary Image Curves formed by a Thin Achromatic Object Glass with the Object Plane at Infinity, by E. WILFRED TAYLOR.

THE GEOLOGICAL SOCIETY OF LONDON.

MAY 16, 1923—PROF. W. W. WATTS, Sc.D., F.R.S., VICE-PRESIDENT, IN THE CHAIR.

The following communications were read:—

The Upper Ordovician Rocks of the South-Western Berwyn Hills, by WILLIAM BERNARD ROBINSON KING, O.B.E., M.A., F.G.S.

A new species of *Calymene* was incidentally described from the upper part of the Ashgillian, where it is taken as a local index-fossil.

The Geology of the District around Corris and Aberllefenni (Merioneth), by PROF. WILLIAM JOHN PUGH, O.B.E., B.A., F.G.S.

ROYAL MICROSCOPICAL SOCIETY.

The section of the Society which has been formed to deal with the Industrial Applications of the Microscope, and to assist in the development of Industrial Research in British Industries, held a meeting at 20, Hanover Square, W.1, on Wednesday, May 30.

The demonstrations and exhibits included the following:—

Mr. M. T. Denne, O.B.E., F.R.M.S., demonstrated an improved apparatus for the production of photomicrographs.

Mr. C. A. Newton gave a demonstration of a new form of microscope lamp for easy exchange of paralleliser and polariser.

Mr. Mansell P. Swift demonstrated a Hutchinson universal goniometer.

The following papers were read:—

On the Microscopical Examination of China Clay, by Mr. Joseph M. Coon.

The Microscopical Investigation of Sands for various Industrial Purposes, by Mr. H. B. Milner.

Professor A. Hutchinson (Pembroke College, Cambridge) presided.

ROYAL INSTITUTION OF GREAT BRITAIN.

On Thursday, June 7, Sir William M. Bayliss, LL.D., D.Sc., F.R.S., gave his second lecture on *The Nature of Enzyme Action*.

THE SIXTH INTERNATIONAL MINING EXHIBITION.

To be Held 4th to 8th June, 1923.

Papers to be read at the Oil Conference:

Monday, June 4.

The Riddle of the Carpathians (Opening Address), by E. H. Cunningham Craig, B.A., F.R.S.E., F.G.S., M.Inst.P.T.

Oil Deposits and the Tectonics of Vertical Pressure, by Dr. Maxmilian Kraus.

Note on the Genesis of Hydrocarbons and their Localisation in certain zones of the Earth's Crust, by R. d'Andrimont.

Tuesday, June 5.

Oilfield Waste, by A. Beeby Thompson, O.B.E., M.I.Mech.E., M.Inst.M.M., M.Inst.P.T., F.G.S.

Thursday, June 7.

The Mode of appearance of the Petroleum Deposits in the Carpathian Region, with General Consideration on the Genesis of the Petroleum and the source of the Actual Deposits, by J. Voitesti, Professor Cluj University.

An Economic Study of Petroleum Mining by Underground Drainage, by Major J. A. Lautier, M.Inst.P.T.

Friday, June 8.

The Standardisation Movement in America and its relation to and application towards the Elimination of Waste in the Petroleum Industry, by C. A. Young and S. D. Tuthill.

The Caribbean Oil Region, by George Howell, F.G.S., F.R.G.S., M.Inst.P.T.

THE CHEMICAL SOCIETY.

Ordinary Scientific Meeting, Thursday, June 7th.

The following papers were read:—

Investigations on the dependence of rotatory power on chemical constitution. Part XX. The rational study of optical properties: Refraction a constitutive property.—H. Hunter.

Researches on indium. Part I. Diphenyl indium chloride and phenyl indium oxide.—A. E. Goddard.

The properties of ammonium nitrate. Part VI. The reciprocal salt pair, ammonium nitrate and potassium sulphate.—E. P. Perman and W. J. Howells.

Ring chain tautomerism. Part VI. The mechanism of the keto-cyclol change in the propane series.—E. W. Lanfear and J. F. Thorpe.

The reversibility of additive reactions. Part I. The aldol reaction.—E. H. Usherwood.

Mechanism of the pinacone-pinacoline and Wagner-Merrwein transformations.—C. K. *Ingold*.

Researches on antimony. Part I. Tri-m-xylylstibine and its derivatives.—A. E. Goddard.

GENERAL NOTES.

URUGUAY.

TENDERS INVITED FOR GENERAL STORES.

The British Vice-Consul at Montevideo has forwarded particulars of the call for tenders for the supply of general store requirements of the State Electric Light Works of Montevideo.

Tenders in sealed envelopes are to be presented at the head offices of the State Electricity Works Administration before 4 p.m., 12th July.

The list of goods required is extensive, including tools, nuts, bolts, greases, lamp shades, cord, files, saws, lumber, stationery, waste, etc. and firms may tender for all or any part of the requirements.

The full list (in Spanish) and a summarised translation of the general conditions of tender can be consulted by interested U.K. firms on application to the Department of Overseas Trade (Room 84).

The Bulgarian State Railways are desirous of receiving tenders for the supply of linseed oil. A public adjudication of tenders will be held on the 15th June.

U.K. firms who are desirous of receiving further particulars should apply to the Department of Overseas Trade (Reference 10754/F.E./C.C./2).

INTERVIEWS WITH THE COMMERCIAL SECRETARY AT COPENHAGEN, DENMARK.

The Commercial Secretary at Copenhagen, Mr. R. M. A. Turner, will be in attendance at the Department of Overseas Trade from the 25th to 30th June, inclusive, and will be pleased to interview, by appointment, United Kingdom manufacturers and merchants interested in export trade to Denmark.

Applications for interviews should be addressed, without delay, to the Department of Overseas Trade, and the reference 7505 F.R. should be quoted.

PUBLIC ANALYST FOR GLOUCESTER COUNTY AND CITY.

The Council of the Institute of Chemistry of Great Britain and Ireland advise any Fellow or Associate of the Institute who may contemplate accepting appointment as Public Analyst for the County of Gloucester or for the City of Gloucester on the terms recently advertised to communicate at once with the Registrar of the Institute.

CANADIAN CHEMICALS AND ALLIED PRODUCTS, 1919-1920.

A special survey of Canada's chemical industries was undertaken by the Dominion Bureau of Statistics as a section of the Industrial Census to provide a directory of Canadian Chemical Industries and their products for the use of the trade. It also served to assemble data regarding raw materials used, products and by-products manufactured, imports and exports, etc., thus indicating not only the importance of the industry and the progress which it has made in Canada, but also possible new and profitable trade openings in industrial chemical lines.

The present report is the result of the first comprehensive survey of the production of chemicals and allied products in Canada.

Industries are grouped by classes according to the principal component materials of their products; on this principle, the present study was carried out in ten main groups, namely: Coal tar and its products; acids, alkalies, salts and compressed gases; explosives, ammunition, fireworks and matches; fertilisers; medicinal and pharmaceutical preparations; pigments, paints and varnishes; soaps, perfumery, cosmetics and other toilet preparations; inks, dyes and colour compounds; wood distillates and extracts; miscellaneous chemical industries. The industries coming under these items in 1920 comprised 456 establishments, employing more than 17,000 hands. A total of nearly $120,000,000 was employed as capital, and products aggregating nearly $122,000,000 in value were made. Pigments, paints and varnishes were easily the leading group. Soaps, perfumery, cosmetics and other toilet preparations came second, with acids, alkalies, salts and compressed gases a close third. Medicinal and pharmaceutical preparations; explosives, ammunition, fireworks and matches; wood dis-

tillates and extracts; fertilisers; inks, dyes and colour compounds; and coal tar and its distillation products followed in the order named.

The continuous advance which represented normal conditions before the war was much accentuated in the last four war years, and it is encouraging to note that during the past two fiscal years the export trade has been maintained at a level very considerably above what the normal pre-war rate of increase would have produced.

Progress in the manufacture of chemicals and allied products in recent years has been rapid and the results attained have more than justified the ventures made. The professional chemist and the chemical manufacturers have combined to advance the common weal, and a feeling of optimism dominates and leads the industry. Opportunities for the development of Canadian chemical industries are being sought out by careful research, and while Canada may not lead the world, there still are some of the chemical industries in which her influence will be strongly felt.

CANADIAN CHEMICAL EXPORTS, 1922.

Exports of chemical products from Canada during the past fiscal year amounted to $14,046,940, as compared with the 1921-22 total of $9,506,170; and exports of automobiles were more than tripled, shipments of trucks amounting to 3,720, worth $1,444,549 (1,296, worth $611,185, in 1921-22); of passenger vehicles 45,108, worth $25,606,359 (13,428, valued at $7,421,619, in 1921-22); and of auto parts $2,355,066, compared with $1,151,453 last year.

PADUA SAMPLE FAIR.

Many foreign countries are to exhibit at the International Sample Fair to take place in Padua (near Venice) in June. This Fair is one of the oldest, if not the oldest, held in Europe.

There is always a good British attendance. Many tourists take the opportunity of visiting this historic town to see the fine array of many categories of products which this event brings together.

The London office of the Italian State Railways & Tourist Department announces that special reduced rate tickets will be issued to Padua during the period of the Fair.

NOTICES OF BOOKS.

The Chemistry of Urea, by Emil A. Werner, M.A., Sc.D., F.I.C. Pp. XII. + 212. London: Longmans, Green & Co., 39, Paternoster, Row, E.C. 1923. Price 14s. net.

The physiological importance of urea in animal metabolism is in itself a sufficient reason for the publication of this volume in the Series of Monographs on Biochemistry under the general editorship of Profs. Plimmer and Hopkins. It will be recalled that urea was the first organic compound to be synthesised without the intervention of "vital force" in 1828 by Wöhler.

In addition, the chemical history of urea is remarkable; this substance, so well-known and thoroughly investigated, has had the erroneous carbamide formula ascribed to it until Prof. Werner's researches became known.

Soon after its discovery and isolation in the latter half of the eighteenth century, it was found to yield CO_2 and NH_3 by hydrolysis and by fermentation. This suggested the carbamide structure and received apparent confirmation from the various attempted syntheses of carbamide, which all yielded urea.

The general reactions and decompositions seemed to agree well with this formula and certain anomalous properties and the occurrence of subsidiary products in the syntheses and decompositions were overlooked or ingeniously explained on the basis of the carbamide formula, the acceptance of which has undoubtedly hindered advancement in the study of urea.

During the last decade the author has published a number of scientific communications, giving an account of his own investigations on the chemistry of urea and the results are incorporated—together with much new matter — in the monograph under review.

It is shown that all the syntheses are really similar to Wöhler's, involving the union of NH_3 with the keto-form of cyanic acid. This is clearly brought out by the author's careful explanation of the mechanism of these syntheses, which have led to his cyclic formula being adopted for this compound.

Further confirmation of this formula is to be found in a study of the reactions of the substance with HNO_2 and NaBrO, although formerly these were regarded as affording proof of the carbamide structure. The

action of hypohalogenites, for example, on urea, was regarded as in complete accord with this, since equal volumes of CO_2 and N_2 were evolved. The fact that the volume of N_2 evolved was decidedly below the theoretical amount was ignored, as was the presence of other gases, *e.g.*, CO, N_2O, and O_2.

The author is easily able to reconcile this behaviour with his formula, which also accounts for all the "anomalies" associated with the reactions of urea. In the estimation of urea by means of NaBrO, no method is known whereby *all* the N_2 can be evolved in one operation, but the author has devised a very satisfactory method involving two simple operations.

The considerable value of this *Monograph* is enhanced by the inclusion of a chapter on *Simple Lecture Experiments* to demonstrate the properties of urea. There are also two useful appendices and a good bibliography and index. J.G.F.D.

Reports on the Progress of Applied Chemistry, issued by THE SOCIETY OF CHEMICAL INDUSTRY. Vol. VII. 1922. Pp. 586.

The chemical and technical advances in chemical industry during the past year are recorded in chapters written by leading authorities in the various branches of the subject.

Each section is not merely a summary of the discoveries and inventions for the period under review, but is more in the nature of an authoritative discussion and statement of the recent developments in the industries concerned.

Over twenty technical chemists of repute have contributed to the Reports.

BOOKS RECEIVED.

Annual Reports of the Society of Chemical Industry on the Progress of Applied Chemistry for 1922 (Vol. VII.). Pp. 586. 1922. Society of Chemical Industry, 46-7, Finsbury Square, E.C.2.

Canada, Dominion Bureau of Statistics, Mining, Metallurgical and Chemical Branch. Chemicals and Allied Products, 1919 *and* 1920. Pp. 150. 1922. F. A. Acland, Ottawa, Canada.

Theoretical Chemistry, from the Standpoint of Avagadro's rule and Thermodynamics, by PROF. WALTER NERNST, PH.D., of the University of Berlin. Pp. XX. + 992. 1923. Messrs. Macmillan & Co., Ltd., St. Martin Street, W.C.2. 28s. net.

PUBLICATIONS RECEIVED.

The Ministry of Agriculture and Fisheries leaflet No. 300, *The Breeding and Utility of Pigeons.*

New Patents.

THIS list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

11900—Cassella & Co., Ges., L.—Manufacture of alkyloxyacridines. May 2.
11971—Cassella & Co., Ges., L.—Manufacture of p-dialkylamino aryiphosphinous acids. May 3.
11849—Damard Lacquer Co., Ltd.—Phenolaldehyde condensation products. May 2.
11616—Goldscmidt Akt. Ges., T.—Process for refining tin. April 30.
12173—Harris, H.—Refining metals. May 5.
11617—Imray, O. Y.—Manufacture of vat dyestuffs from anthraquinone. April 30.
12017—Johnson & Sons, Manufacturing Chemists Ltd.—Thermometer stand. May 4.
12502—Gray, E. L.—Recovery of caustic alkali used in digesting cellulose, etc. material *and simultaneous production of oxalic acid.* May 9.
12366—New Jersey Zinc Co.—Manufacture of zinc oxide. May 8.
12469—Soc. of Chemical Industry in Basle.—Manufacture of dye-stuffs of indigo tint. May 9.

Specifications Published this Week.

196658—Mehner, H.—Process and furnaces for carrying out chemical reactions and physical processes at high temperatures.
196672—King, O.—Amido-phenol compounds.
177494—Soc. Chimique de la Grande-Paroisse.—*Synthesis of ammonia by means of hyper-pressures.*
191002—Soc. Ricard, Allenet et Cie.—Manufacture of butyl chlorides.

Abstract Published this Week.

194840—Dyeing cellulose acetate—R. Clavel, Augst, Basle, Switzerland.

Aniline-black and like dyeing.—Black shades are obtained on cellulose acetate silk, films, &c., by impregnating the material with diphenyl black ase and acids, with or without salts or protective colloids, and developing by oxidation. According to examples: acetate silk is impregnated in the cold with a solution containing diphenyl black base, acetic acid, lactic acid, aluminium, chromium, and cupric chlorides, and sodium chlorate, and developed in a drying room at 80° C.; acetate silk is treated at 50-60° C. in a bath containing diphenyl black base, *acetic acid, and boiled-off* liquor, and developed in a bath of ammonium persulphate; or oxidising-agents such as hypochlorate, chloride of lime, persulphate, or perborate, may be added to the exhausted dyebath. Specification 182,830 is referred to.

Messrs. Rayner & Co. will obtain printed copies of the published specifications only, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,
VOL. CXXVI. No. 3296.

A CHEMICAL BASIS FOR THE TREATMENT OF TUBERCULOSIS.

By Louise G. Robinovitch, B.es.L., M.D.

[A Preliminary Statement of Research Work in the Chemical Laboratories of the Colorado School of Mines.]

The main part of the tubercle bacillus is generally regarded as consisting of waxy and fatty matter, free fatty acids, and otherother organic substances. It appears that the waxy coating is the main protection to the bacillus and offers the greatest resistance to chemical attack. If this waxy and fatty matter could be chemically decomposed and destroyed by agents not injurious to living tissue, it seems reasonable to assume that a cure for tuberculosis should lie in such a treatment. This abstract presents a brief outline of the essential features of such a method of attack, developed on the basis of the above assumptions and line of reasoning.

The apparent success of this new treatment depends largely on the agent which I have found to be an effective solvent for the *tubercle bacillus*. It consists of a highly concentrated, slightly alkaline, glycerol extract of steapsin or lipase, and probably insulin into which has been incorporated a small amount of chloroform. The pure extract of insulin will probably make it possible to use smaller doses of the fat-splitting agent more effectively. Potassium bicarbonate was used to obtain the desired alkalinity. Small doses of bile salts (prepared from ox bile) administered orally increased the effectiveness of the above agent.

An important adjunct to the chemical treatment of the disease is activated oxygen, which acts as does a radio-active ray, by releasing its negative electric charge.

HELIUM AND ITS USES.

The following account of helium and its uses is based upon one issued by the British Science Guild, by Prof. J. C. McLellan, F.R.S.

As is well known, helium is one of the chief constituents of prominences in the sun which shoot out from this body a distance of many thousand miles, as seen during its total eclipse. In 1868 Sir Norman Lockyer announced the discovery of this element in the sun by spectroscopic observation and named it *helium*. In 1895 Sir Wm. Ramsay obtained helium from a mineral, clevite, along with argon. Helium occurs in radio-active changes as the alpha particle which is ejected from the disintegrating atom in some cases, and where this type of activity is intense, at a velocity as high as 12,000 miles per second. Sir E. Rutherford has made use of the high velocity of the alpha particle in using it as a projectile for breaking up the nitrogen atom, but the quantities dealt with are infinitesimal.

Of particular interest are the sources from which helium is now obtained. It exists in the atomsphere in the proportion of about four parts to one million of air, by volume; but it exists in much higher percentages in natural gases reaching the present known limit of 1 or 2 per cent. therein in the gas wells situated in the western States of America, particularly in Texas.

In France, some springs yield as much as 5 per cent. It is widely distributed, though in Great Britain the supply is almost negligible, being only one-fifth per cent. in the natural as at Heathfield, Sussex. At King Spring, Bath, one-sixth per cent. has been found. Canada affords the richest supply so far discovered in the Empire, the localities being Ontario and Alberta, but the percentages are low, being about one-third per cent. of the natural gases. See concluding statement.

Activity in obtaining helium has reached a commercial stage in the United States, where from 30,000 to 40,000 cubic feet of this gas are now being extracted daily, but its export is prohibited by law. Sir Richard Threlfall had suggested in 1915 an inquiry into the helium content of supplies of natural gas within the Empire, and the United States began developing the industry two years after the war.

It is instructive to record that this element was a chemical curiosity immediately prior to 1918, at which time 100 cubic feet would have cost about £300 to collect, and since then nearly three million cubic feet of this gas have been extracted in the United States for use in the American Army and Navy. It is compressed and stored in steel cylinders for use in airships and other purposes.

With regard to its uses, it has just been announced that new airships of the rigid type are approaching completion for the U.S. Government, and that they are being inflated with helium instead of hydrogen, the latter gas being, of course, highly explosive and inflammable. Helium, being *non-inflammable and non-explosive*, and giving a lifting power of 92 per cent. of that of hydrogen, the desirability of its use in *inflating the airship envelopes is made* evident. For this purpose hydrogen can be mixed with helium to the extent of 15 per cent. *without the mixture being inflammable* or explosive in air. As a matter of fact, the engines of airships can be placed within the gas envelope is desired, and a further advantage of helium over hydrogen is that the buoyancy can be increased at will by heating or cooling the gas by electric heaters or other means. Moreover, helium diffuses through the envelope about 30 per cent. less than hydrogen.

It is stated that helium can be used to fill thermionic amplifying valves for use in wireless telephony, and also used as a filler *for metal filament lamps and arc lamps*

Prof. Onnes, of Leyden, in 1908, succeeded in liquefying helium having reached *a temperature of 490° F. below the freezing* point of water, which is within 2 or 3 degrees of the absolute zero. Using liquid *helium as a cooling agent, Prof. Onnes* found that a number of metals became practically perfect conductors of electricity when cooled down to within a few degrees of absolute zero. An electric current induced in a closed conductor by magnetic induction continued to flow for more than an hour, in this instance the metal being lead. Mercury was also used with a similar result. This is called "super-conductivity," for the metal becomes many million times more conducting at this low temperature than at room temperature.

Under the title, "*Need for Development*," Prof. McLennan says:—

"From ten to twelve million cubic feet of helium could, however, be obtained annually from natural gases in Canada, and the gas has such direct bearing upon problems of scientific and practical importance that the Governments of Great Britain and Canada might, even from the point of view of national safety, legitimately be asked to follow the example of the United States and operate the plant which was constructed during the late war and was erected and operated for a time at Calgary. With this plant it was shown that helium of high purity could be produced at less than fivepence a cubic foot. With suggestions received from Prof. Kamerlingh Onnes, of Leyden, and with financial assistance received from the Honorary Advisory Council for Scientific and Industrial Research of Canada, the Carnegie Foundation for Research and the University of Toronto, a magnificent cryogenic equipment has *been installed in the Physical Laboratory* of the University of Toronto. With it large supplies of liquid air, liquid hydrogen and *liquid helium can be obtained*. This cryogenic laboratory was opened on January 10 last, and on that occasion demonstrations were given of the production of liquid air, liquid hydrogen, and liquid helium in quantity. It is hoped that the facilities of this laboratory will be used by workers in low temperature research who may find it inconvenient to go to Leyden to work under Prof. Onnes, the distinguished physicist of the Netherlands."

ON γ RAYS FROM RADIUM D AND RADIUM E.

By Mlle. I. Curie and M. G. Fournier.

A strong preparation of Radium D mixed with some milligrams of lead was employed. The rays were studied and characterised by their absorption in aluminium.

Method of Procedure.—The measuring apparatus was a vertical cylinder, of which the upper half contained a gold leaf electroscope and the lower half constituted an ionisation chamber closed by a thin leaf of aluminium 5.5 centimetres in diameter. This apparatus was placed several centimetres above the poles of an electro-magnet giving a field sufficient to completely eliminate the β-rays. The active source was placed in a quartz crucible between the poles at 12 centimetres from the electroscope. The absorbing screens were put very near the leaf which closed the electroscope.

Measurements and Results.

The absorption curves were traced as abscissæ.

The examination of the curve obtained shows that the intensity could be expressed:

$$I = I_1 e^{-w_1 m} + I_2 e^{-w_2 m} + I_3 e^{-w_3 m}$$

where m = mass per square centimetre of the interposed screens; I_1, I_2, I_3, the initial

intensity of the three rays, ω_1, ω_2, ω_3, their coefficients of mass of absorption (often denoted by $\frac{\mu}{\rho}$).

It is necessary to note that the γ-ray of Polonium, whose mass coefficient of absorption was found equal to 230 (indicated by Chadwick and recently confirmed by Mme. Curie) is too much absorbed to intervene in the curves with which we are concerned. After obtaining certain data, the authors proceeded to some chemical operation with a view to separate the Radium D and Radium E.

The mixture was dissolved in hot nitric acid and Radium D, crystallised on cooling after concentration, lead nitrate being insoluble in concentrated cold nitric acid. Radium E. separated in this way is still slightly mixed with lead and Radium D. The polonium was finally separated by deposition on a silver blade.

The absorption curves corresponding to the two portions, Radium D and Radium E, were traced as soon as possible after separation.

The changes shown in the curves by the destruction of Radium D in one portion separated by its reformation into the other were studied at the same time as we followed the evolution of the quantity of Radium E by measuring these β-rays with the aid of an electrometric installation.

A study of the curves obtained shows that the penetrating rays III arise from Radium E.

The results are shown to be in good accord with those of Rutherford and Richardson, who give mass coefficients 16.5 and 0.36 respectively for rays I and II.

The authors have established the existence of penetrating rays III, attributable to Radium E. Their coefficient of absorption has also been determined.—(*Comptes Rendus*, 1923, CLXXVI., 1301-4.)

IS THERE AN ELEMENT OF ZERO ATOMIC NUMBER?—III.*

By F. H. Loring.

In pursuance of this study, it is of interest to note that Sir E. Rutherford (*Bakerian Lecture*: *Prof. Roy. Soc.*, 1920, Vol. XCVII., p. 398) suggests that it is by no means impossible for an atom of mass 1 to exist with zero nuclear charge. "On present views," quoting from the above lecture, "the neutral hydrogen atom is regarded as a nucleus of unit charge with an electron attached at a distance, and the spectrum of hydrogen is ascribed to the movements of this distant electron. Under some conditions, however, it may be possible for an electron to combine much more closely with the H nucleus (proton), forming a kind of neutral doublet. Such an atom would have very novel properties. Its external field would be practically zero, except very close to the nucleus, and in consequence it should be able to move freely through matter. Its presence would probably be difficult to detect by the spectroscope, and it may be impossible to contain it in a sealed vessel. On the other hand, it should enter readily the structure of atoms . . ."

Prof. Eddington, in his book, *Mathematical Theory of Relativity*, discusses this problem from the energy or mass side, and he points out that the complete neutralisation of a proton by an electron might give rise to an appreciable loss of mass that would pass out as electromagnetic radiation.

It will be seen that these ideas involve a nuclear atom of zero atomic number; only in the case of complete neutralisation such an element would become more or less massless, if Eddington is correct in his surmise.

In the instance of *complete* neutralisation, it is supposed that the electron and the proton *coalesce*, *i.e.*, that they merge to form one entity if such an entity can preserve its existence as such. Now, Sir J. J. Thomson puts forward the view, which has been under consideration for some time, that when the electron approaches sufficiently near to the positive nucleus, then a repulsion sets in. Sir J. J. Thomson, in the *Journal of the Franklin Institute*, May, 1923, page 597, says: — "I shall assume that the law of force between a positive charge and an electron is expressed by the equation—

$$F = \frac{Ee}{r^2}\left(1 - \frac{c}{r}\right),$$

where

F = attraction between the charges.

* *See "Chemical News," this volume, pages* 307 *and* 325.

E = the positive charge on the core,

e = the negative charge on the electron,

r = *the distance between them*,

c = a constant varying from one kind of atom to another; it is the distance at which the force changes from attraction to repulsion and is of the order of 10^{-8} cm.

Sir J. J. Thomson remarks that if the law of force is that just given, "then a number of electrons can be in stable equilibrium round a charge without necessarily describing orbits round it." In this connection, Sir J. J. Thomson calls attention to Ernshaw's theorem: that no stable configuration in which the electrons are at rest or oscillate about stable positions is possible when using only the inverse-square law of distance. Furthermore, an example is given which makes planetary phenomena non-applicable to the atom, for in the case of Saturn's rings, the particles do not repel each other as the electrons do. In this treatment of the problem it is assumed that the ordinary law of attraction applies at considerable distances, but when the distance becomes sub-atomic, so to speak, then the law no longer applies, and this introduces a new law, as indicated above.

The argument in its present development leads again to the improbability of there being an atom, or nuclear magnitude, of zero atomic number, and it is necessary to fall back upon the reasoning of Part II., in which the electron was the only entity that could have a place before hydrogen and its zero atomic number was only acquired by virtue of its neutralising quality, though this property is limited if the views of Sir J. J. Thomson are correct. In short, the electron cannot coalesce with the proton and form a stable system.

We have here a case of scientists of great eminence working out different explanations of phenomena which seem at variance in some fundamental respects.

The subject is of interest, in the writer's opinion, and some further views may be offered.

A PERIODIC FUNCTION OF ATOMIC WEIGHTS.

By Alexander Sakoschansky, B.Sc.

There exists in the periodic system, certain groups of elements, which establish a numerical relationship between the elements, and with which atomic weights can be calculated.

The arrangement of the elements, calcium, rubidium, vanadium, cerium, and phosphorus, in the a group of six elements, can be described in the following way: Ca is diagonally adjacent to Rb on its left, and V is separated by an interval of two elements to the right; Ce is vertically adjacent to the element which is diagonally adjacent to the left to V. Phosphorus of the same valency as V is the eighth element from it. The sixth member of the group is bound by the arithmetical-chemical identity:—

$$\frac{Ce}{V} \cdot \frac{Ca}{Rb} = \frac{4}{P}.$$

In the following group Cl. forms a pair with S in the same way as P and Ar or Ca. Cl. is the seventh element from Cr. The pair of elements on the right-hand side of the equation are adjacent in the periodic system, with the exception of phosphorus. The five groups are tabulated, with intervals and valencies shown.

$$\overset{III.}{\frac{Fe}{Ag} \cdot \frac{Zr}{V}} = \overset{III.}{\frac{Sc}{Ti}}\ (5)$$

$$\overset{VII.}{\frac{Mn}{Cd} \cdot \frac{T}{Ti}} = \overset{VII.}{\frac{Cl}{K}}\ (6)$$

$$\overset{VI.}{\frac{Cr}{In} \cdot \frac{Sr}{Sc}} = \overset{VI.}{\frac{S}{Cl}}\ (7)$$

$$\frac{Ce}{U} \cdot \frac{Ca}{Rb} = \frac{4}{P}\ (8)$$

$$\frac{La}{Ti} \cdot \frac{K}{Kr} = \frac{1}{Al^3}\ (9)$$

EINSTEIN'S THEORY OF RELATIVITY.

FURTHER ECLIPSE TEST PHOTOGRAPHS NOT NECESSARY.

The examination of the photographs taken during last September's total eclipse of the sun has resulted in a remarkable verification of the curvature of space and the bending of light rays demanded by Einstein's theory of Relativity Gravitation. The American, Canadian and Australian parties submitted the theory to critical test.

The photographs obtained by Prof. Chant, of Toronto, and Dr. Campbell, of the Lick Observatory, have now been carefully measured, and the necessary mathematical computations made, with the result that all the stars shown have been found to be displaced by the exact amount predicted by Einstein. It was proposed to repeat the test next September, at the time of the total eclipse visible in N. America, but Dr. Campbell is so convinced by the results of last year's eclipse, and those of 1919 by Greenwich astronomers in Brazil, that there can now be no possible doubt as to the correctness of the Relativity theory, and that further corroboration, so far as the eclipse test is concerned, is quite unnecessary.

The measurements of the Australian plates have not yet been completed, the task being now in progress at Greenwich, but they are believed to be as conclusive as those taken by the Canadians and Americans. It may now be taken that Relativity has survived two of the three tests to which it can be subjected—those depending on the deflection of light passing near massive bodies in space and the movement of the orbit of the planet Mercury in defiance of Newton's laws. The third test, which involves a change in the position of certain lines in the sun's spectrum, is the most difficult of the three to apply, and no definite result has yet been obtained. But Professor Einstein is confident he will obtain clear evidence of this shift of the solar spectral lines by means of a special apparatus he has had erected at Potsdam Observatory.

There is, however, no likelihood of any more Einstein photographs being taken when the sun is eclipsed. It is a costly work, and prevents astronomers undertaking other eclipse observations.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, JUNE 14.

Papers read:—

C. CHREE, F.R.S. *Magnetic Phenomena in the Region of the South Magnetic Pole.*

O. R. HOWELL. *The Catalytic Decomposition of Sodium Hypochlorite by Cobalt Peroxide.* Communicated by Prof. T. M. Lowry, F.R.S.

NINA M. HOSALI. *The Seismic Waves in a Visco-Elastic Earth.* Communicated by Prof. L. N. G. Filon, F.R.S.

Papers read in title only:—

J. W. LANDON and H. QUINNEY. *Experiments with the Hopkinson Pressure Bar.* Communicated by Sir Alfred Ewing, F.R.S.

S. F. GRACE. *Free Motion of a Sphere in a Rotating Liquid at Right Angles to the Axis of Rotation.* Communicated by G. I. Taylor, F.R.S.

B. F. J. SCHONLAND. *The Passage of Cathode Rays through Matter.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

THURSDAY, JUNE 7.

Papers read:—

SIR CHARLES SHERRINGTON, P.R.S., and E. G. T. LIDDELL. *Stimulus Rhythm in Reflex Tetanic Contraction.*

K. N. MOSS. *Some Effects of High Air Temperatures and Muscular Exertion upon Colliers.* Communicated by Dr. J. S. Haldane, F.R.S.

Paper read in title only:—

F. A. E. CREW. *The Significance of an Anchondroplasia-like Condition met with in Cattle.* Communicated by Sir Arthur Keith, F.R.S.

The Croonian Lecture will be delivered on June 21, by Dr. F. F. Blackman, F.R.S., on *Plant Respiration as a Catalytic Process.*

THE FARADAY SOCIETY.

General Discussion on the Physical Chemistry of the Photographic Process.

At the meetings on May 28.

(*Concluded from Page 362.*)

On the Sensitivity of a Silver Bromide Emulsion, by Walter Clark, M.Sc., A.I.C.

Consideration of some of the older work of Lüppo-Cramer, Reinders, Bancroft and others establishes beyond doubt the heterogeneity of the silver haloid grains of a photographic emulsion. In a purely mathematical or physical investigation of the complex problems of the photographic plate, such a course would probably be a natural one to pursue, as representing the simplest possible case. Since, however, the whole problem of sensitivity seems to be bound up with the presence of traces of material which is not silver haloid, the problem is one which is not capable of solution by the mathematician or the physicist alone. Before the physical laws underlying the photographic process can be completely elucidated it will be necessary for a complete chemical investigation to be carried out in connection with the actual process of emulsion making and the effects of subsequent treatment on the finished plate. The problem will probably involve the application of the laws of heterogeneous equilibria, and of a study of the formation of complexes and of the process of adsorption.

The sensitivity of a fast plate is due primarily to grains of material which is not silver bromide. By removal of the latent light-image with chromic acid solution, the speed of a fast plate is reduced to a certain low minimum. This is a natural consequence of the existence of a limited amount of substance in the grains, to which their high sensitivity is due. It is quite probable that the sensitivity promoting material has of itself little or no sensitivity to light, but that it acts as a sort of photocatalyst by increasing sensitivity.

The reduction of sensitivity of a plate by destruction of the latent light image by chromic acid is much more marked than that brought about by merely bathing a plate in chromic acid without a preliminary exposure. Also the fog resulting from the action of hydrogen-peroxide, turpentine vapour, nitric, sulphuric, and hydrochloric acids is eliminated by bathing the plate in a mixture of pina-flavol, alkali bromide and acetic acid.

The product of the action of light (and fogging agents) on the plate is much more readily attacked by chromic acid (and acid-bromide-dye mixtures) than is the sensitivity-giving material itself, although this latter is slowly attacked.

The Chemistry of the Red Toning of Sulphide-Toned Prints, by A. and L. Lumière and A. Seyewetz (Paris). Communicated by A. F. Clerc (Paris).

Summary:

Silver images which have been sulphide toned obtain a colour ranging from brown to red chalk in a solution of gold chloride to which has been added a sulphur compound, such as thiourea, thiosinamine, ammonium sulphocyanide, or ammonium thiosulphate.

This toning takes place only with silver sulphide and only on the condition that a sulphur compound is present in the gold toning bath.

The silver sulphide, during the toning process, fixes a very considerable quantity (about 133 per cent. of the weight of the silver) of gold and also a certain proportion of sulphur, somewhat greater than that corresponding with the formation of gold sulphide.

The toned image thus appears to consist of a double sulphide of silver and gold.

Some Future Problems in Photography, by J. Plotnikov.

From the standpoint of pure photochemical research the investigation of the properties of the photographic plate is full of difficulties, because the photochemist is interested, before everything, in the investigation of reactions, taking place under simple conditions, where the photo-chemical properties and laws are most obvious. The photographic plate, however, is the most complicated thing imaginable, the complications being artificially increased in order to obtain various desired technical

effects. For photo-chemical investigations the pure salts of silver should be used, as was done only recently by Schwarz and Stock, Hartung, Koch and du Prel, Fajans, and others; even more desirable would be an investigation of pure solutions of silver salts.

The silver salts are in a state of fine dispersion in the medium (gelatin), which, itself, is colloidal and therefore not homogeneous. The molecular weight of the silver salts under such conditions is unknown, and is apparently dependent on the way in which they are obtained. They form, with the gelatin, complex salts of an unknown structure and probably also of variable composition. The gelatin itself, as a medium, will have an influence, which cannot be strictly defined, on the photochemical reaction, and this influence will vary with the source and the mode of preparation of the gelatin. Moreover, the gelatin adsorbs and binds chemically the free halogens. The silver salts also adsorb various impurities, which again may influence the photo-chemical process.

The blackening of the plate is an unknown function of the dispersity and of the granular size of the grains of the silver salts. The extent of the surface of the grains exposed to the influence of light is unknown and variable; also the gelatin acts as a screen. It follows that the conditions of light in such a dull medium cannot be simple, since there is: reflection of light fro mthe outer surface of the gelatin outwards, from the inner surface of the glass into the gelatin, and from the individual grains; mutual covering of the individua grains; scattering of the light and photochemical and thermal adsorption of light in the grains themselves and in the medium.

The blackening of the photographic plate is not a true representation of the primary photo-chemical process but a summation effect of all the innumerable and indefinable factors referred to above, which factors are sometimes quite accidental and arbitrary in character. Just as it was in the time of Daguerre, the photographic plate is a work of art, which can be used as an aid in scientific investigations, but cannot be the object of scientific research.

Nucleus Isolation and Desensitisation, by Dr. Luppo-Cramer (Schweinfurt, Bavaria).

Since my first communication I have obtained results which open up new points of view in the consideration of dye-reactions. One piece of evidence in support of the oxidation theory of desensitisation was, that if an exposed silver bromide plate was bathed in a solution containing a bromide and a desensitising dye, further exposure to light bleached the latent image. At first, sensitising dyes, for example, erythrosin and rhodamine, did not give this reaction, which consequently appeared to me to be due to the desensitising (oxidising) action of the safranines. In a new series of experiments, however, and contrary to expectation, it has been found that some typical sensitisers, for example, ethylcyanine and pinaflavol in the presence of a bromide and in weakly acid solutions, have a much more destructive action on the latent image than the safranines. Moreover, in the presence of bromide, some sensitisers destroy the latent image to a great extent even in neutral solutions, whereas phenosafranine, for example, has only a slight photographic reducin action even in the presence of bromide. Developers (metol, and even quinol) in the presence of potassium bromide, also reduced photographically the latent image to a greater or lesser extent, whilst in all these cases bromide alone is practically without action. It appears that in all these reactions the bromide is the real oxidising agent, the dyes and developers only facilitating the attack of the oxidiser. In a preliminary way, I have assumed that the dyes, etc., when they are adsorbed by the silver bromide, isolate the exposed nuclei by a kind of adsorption replacement, and thus make possible the attack of even very weak oxidising agents. As is well known, S. E. Sheppard and G. Meyer assume that developers are adsorbed by silver bromide, although I am not in agreement with their view that the accelerating action which iodides have on development can be explained in this way.

I have previously considered the desensitising action of the safranines to be due to their behaviour as oxidising agents, but in the light of the facts just mentioned, the bleaching of the latent image in the presence of potassium bromide can no longer be ascribed to an oxidising action of the dye, and consequently the facts in support of my theory go by the board. This theory however, is not completely overthrown, since all known desensitisers possess weakly oxidising properties.

Strict proofs in favour of or against the oxidation theory of desensitisers are certainly to be desired, but it is scarcely to be expected that a definite decision can be arrived at by means of reactions carried out in a test tube, since it is just their relatively small oxidising power which appears to make the desensitisers suitable for their typical reactions. If the dyes were stronger oxidising agents they would of themselves (without bromide) reduce photographically the latent imake, that is, they would be of no practical use.

I give reasons for discarding the chief proofs which I gave originally in support of my oxidation theory, but one must demand of other theories that they are also supported by experimental proof.

ROYAL SOCIETY OF ARTS.

The Sir George Birdwood Memorial Lecture, entitled *The Influence of Race on Early Indian Art*, by SIR JOHN H. MARSHAL, C.I.E., M.A., LITT.D., F.S.A., Director-General of Archæology in India, will be delivered on Friday, June 15, 1923, at 4.30 p.m. The Most Honourable the Marquess Curzon of Kedleston, K.G., G.C.S.I., G.C.I.E., P.C., F.R.S., Secretary of State for Foreign Affairs, will preside.

ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on June 15, at 9 o'clock, will be delivered by SIR ERNEST RUTHERFORD, LL.D., D.Sc., F.R.S., M.R.I., Prof. of Natural Philosophy. The subject is *The Life History of an Alpha Particle from Radium.*

Afternoon Lecture at 3 o'clock.—On Saturday, June 16, SIR ERNEST RUTHERFORD, LL.D., D.Sc., F.R.S., will give his sixth lecture on *Atomic Projectiles and their Properties.*

A General Meeting of the members of the Royal Institution was held on June 4, the Duke of Northumberland (President) in the chair. It was announced that the Managers had elected Sir William Bragg, Fullerian Professor of Chemistry, Director of the Laboratory, Superintendent of the House, and Director of the Davy Faraday Research Laboratory. The thanks of the members were returned to Dr. J. J. S. Rowe for his donation of £1 to the fund for experimental research. The Secretary reported the decease of Professor E. W. Morley, an honorary member of the Institution, and a resolution of condolence with the relatives was passed. Mr. G. E. Gask, Mr. John Lister, Mr. P. Ainsworth Means, Mrs. Robert Mond, Mr. F. C. Oldfield, Mr. Edward Talbot Paris, Sir Frederick Rice, Mr. C. M. O. Rovsing, and Mr. W. S. Rowntree were elected members.

THE CHEMICAL SOCIETY.

A lecture was delivered by PROFESSOR CHARLES MOUREU (President of the Société Chimique de France), entitled *Les Gaz Rares des Sources Thermales, des Grisous et Autres Gaz Naturels*, on Thursday, June 14, at 8.30 p.m., in the Society's Rooms, Burlington House.

PHYSICAL SOCIETY OF LONDON.

At the meeting held on May 25, Alexander Russell, M.A., D.Sc., in the chair, the following papers were read:—

The Effect of Torsion on the Thermal and Electrical Conductivities of Metals, by PROF. C. H. LEES, D.Sc., F.R.S., and J. E. CALTHROP, B.A., B.Sc.

A method is described which enables the effect on the thermal conductivity of a wire of twisting the wire to be measured. In each of the steel, aluminium, copper and lead wires tested the twist decreases the conductivity along the wire by a small amount which is approximately proportional to the square of the twist per unit length.

The change of electrical conductivity is found to be in general less than the change of thermal conductivity, but is also approximately proportional to the square of the twist per unit length.

In the discussion, Mr. C. R. Darling said that the method described seemed an admirable one, but wished to know whether the wires were annealed before the experiment? The initial condition of the specimens would doubtless affect the results obtained, and might account for the discre-

pancies between the conclusions arrived at by different observers.

Mr. Rollo Appleyard also referred to the effect of annealing the wire under test, and added that the effect of stretching on resistance is at least as important as that of twisting. In stranding copper wires for a cable the outer wires are stretched as well as twisted, and any permanent increase of resistance due to such causes is of some consequence in practice. It would be interesting if the experiments could be carried out on a large scale, instead of on a laboratory scale.

Prof. A. O. Rankine inquired whether the effect differs according as the direction of twist is clockwise or counter-clockwise as viewed in the direction of flow of the heat or electric current.

Mr. F. E. Smith suggested that the experiments might be simplified by means of an arrangement for producing a potential difference between the two clamps C, shown in the paper, at the ends of the wire. The necessary heating would be effected by the current thereby set up along the wire, which would have a maximum temperature at its middle point owing to the cooling effect of the masses of metal at its ends. The required thermal and electrical measurements could be made by means of wires twisted on to the principal wire as described in the paper.

Dr. Alexander Russell expressed his admiration for the methods of measurement devised by the authors. He pointed out that the twisting of the strands in a stranded cable produces a somewhat similar effect.

Prof. Lees, in reply, said that the wires were soft and not annealed. The object of the experiments was to test the electron theory of conduction, and it was sufficient for this purpose that the state of the wire should merely be the same for the electrical as for the thermal measurements. The large scale tests which had been suggested presented attractions for the engineer, but any accuracy lost by performing the experiments on a small scale was fully compensated by the more precise methods available in a laboratory, while the relatively small cost of the latter methods is a serious consideration to the physicist. The effect of stretching has been investigated by Johnstone, and a reference to his work is given in the paper. The thermal conductivity is increased by stretching while the electrical conductivity is diminished—another instance of failure in the relation predicted by the electron theory. Prof. Rankine's suggestion was an interesting one. It had been considered, but rejected as improbable; it might, however, be worth investigation. The method suggested by Mr. Smith was somewhat similar to that of Jäger and Diesselhorst, but the latter requires the thermal flow to pass through joints, and inaccuracies arise from this circumstance. As regards stranded cables, the effects of twisting and stretching are in opposite directions for thermal conductivity, but aid one another in the case of electrical conductivity, so that the matter would probably repay investigation.

The Use of the Wien Bridge for the Measurement of the Losses in Dielectrics at High Voltages, with Special Reference to Electric Cables, by A. Rosen, B.Sc., A.M.I.E.E.

In the preliminary section, the loss angle of an imperfect condenser is defined, the equations for the Wien bridge are derived, and the effects of variations of frequency and voltage on the balance are discussed.

One of the difficulties in the application of large potential differences to a bridge is the effect on the arm which has to withstand the high voltage. In the arrangements due to Monasch and Schering, this arm is the known condenser; in the bridge as used by the author, the voltage is applied to the ratio coils. The errors introduced by earth impedance are eliminated by using the Wagner auxiliary bridge.

The applications to measurements on cables are considered, and the use of the double bridge in determining the "wire-to-wire" and "wire-to-sheath" losses in a multi-core cable is described.

An Experiment on the Production of an Intermittent Pressure by Boiling Water, by Chas. R. Darling, F.Inst.P., F.I.C.

If a glass tube, open at both ends, and of about 5 mm. bore, be placed in a beaker of briskly boiling water so as to rest on the bottom of the beaker, steam bubbles will be observed to form at the point of contact, causing the water to rise to a definite height in the tube. The column of water thus raised sinks after a time, and then rises again, the rising and falling occurring at irregular intervals. If, however, the tube be narrowed to a bore of about 1 mm.

near the top of the water, and widened out considerably just above the water surface, it will then be seen that the phenomenon becomes regular in action. After rising to the height of about 3 cm. in the widened part, the water discharges back again into the beaker, and after a short interval again rises and is discharged, the cycle being repeated indefinitely.

The explanation appears to be that the water is superheated at the points of contact of the tube and beaker, so that the steam produced can sustain a higher pressure of water. When the water reaches the widened part, however, it is cooled and increases in density until the extra steam pressure at the bottom of the tube is overcome, when it discharges completely. The capillary bore slows down the rate of flow in both directions, and so causes the movements to be steady. A separating funnel with open tap and short stem is well suited to the experiment.

It will be observed that the arrangement constitutes a simple heat engine, with source and sink, automatically passing through a regular cycle of operations, and forms a useful lecture demonstration of the conversion of heat into work.

A Demonstration of *A Novel Instrument for Recording Wireless Signals* was given by N. W. McLachlan, D.Sc., M.I.E.E.

The device consists essentially of a drum of Swedish iron with an annular recess, in which are situated coils of fine wire, the ends of the coils being connected to corresponding slip rings. The periphery of the drum is faced with cast iron rings which are machined to run true to 0.0001 in. A small steel shoe rides on the rings, and side play is prevented by a brass guide-piece with a projection which fits into the annular recess. At each end of the guide-piece a hook is formed, and one of the hooks is connected by a light rod to a duralumin lever pivoted to turn in a horizontal plane. A silver syphon passes through the lever from an ink well overhead, and rests lightly on a moving paper tape. To the other side of the lever is attached a strong spring whose tension can be varied, while the remaining hook is attached to a light spring which prevents the shoe from rocking on the drum.

The drum is revolved by a small electric motor, and when a current flows in one of the coils the shoe is attracted to the drum and a large pull is required to prevent relative motion o fthe two. This pull is used to actuate the syphon lever mechanism so that the transverse movement over the paper tape inscribes the incoming message as a series of rectangles, the tops of which represent the dots and dashes of the Morse code.

The tangential pull on the shoe is many times that calculated from the formula $\mu B^2 A/8\pi$, where μ = coefficient of friction, B = flux density at shoe contact, and A = area of contact. The ratio of the actual to the calculated pull depends on the flux density, and has a maximum value of about 80 for steel or cast iron.

Owing to this phenomenon, which gives amplification, and to the fact that there is no air-gap in the magnetic circuit through the shoe, the instrument is extremely sensitive, and will work at a speed of 150 words a minute with a current of 25 microamperes. It will work in a thermionic valve circuit, and for wireless it is fitted with relay contacts so that incoming messages in Morse may be relayed to a printing or other machine direct.

A meeting of the Society was held on Friday, June 8, when Prof. James G. Gray, D.Sc., F.R.S.E., Cargill Professor of Applied Physics in the University of Glasgow, delivered a lecture entitled, *A General Solution of the Problem of Finding the True Vertical for All Types of Marine and Aerial Craft.* The lecture was accompanied by demonstrations with gyroscopes, and discussion followed.

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated to the Society:—

On the Beckmann Transformation of Nitrosoketones, by Shintaro Kodama.

On the Alleged Phenylglyoxal, by Shintaro Kodama.

On the Proteins in Fagopyrum esculentum, and their Nutritive Values, by Yoshihiko Matsuyama.

On the Quantities of Tryptophan in Various Proteins, by Yoshihiko Matsuyama and Takajiro Mori.

On the Condensation of Nitriles with Thiamides. Part II. Acetnitrile with Thiobenzamide; and Benzonitrile with Thioacetamide, by SEIICHI ISHIKAWA.

On the Destructive Action of Nitric Acid upon Phenols, by MOTOE IWATA.

On the Ternary System: Ethyl Alcohol—Ethyl Ether—Water, by MASUTARO KONO.

THE INSTITUTE OF PHYSICS.

At the last meeting of the Board, the following Corporate Members were elected:—Fellows: J. H. G. Monypenny, J. H. T. Roberts, R. C. Richards, G. C. Simpson. Associates: A. Adderley, W. T. Astbury, F. G. C. Bratt, P. A. Curry, G. A. R. Foster, A. E. Owen, and J. H. Smith.

"THE JOURNAL OF SCIENTIFIC INSTRUMENTS."

The preliminary arrangements in connection with the regular publication of *The Journal of Scientific Instruments* have now been made by the Institute of Physics in cooperation with the National Physical Laboratory. The special attention of those workers who have new designs for instruments is called to the fact that the Journal is to serve as a medium of publication of detailed descriptions and critical surveys of the behaviour of such instruments. Original papers or laboratory and workshop notes dealing with the practical or theoretical aspects of scientific instruments should be sent to the Editor, Dr. John S. Anderson, The National Physical Laboratory, Teddington, Middlesex.

GENERAL NOTES.

In the *House of Commons recently*, Mr. Herbert Spencer asked the President of the Board of Trade whether he was aware that *on the 8th of March, 1923, an application* was made to import one ton each of rosazeine B extra and rhodamine B extra; whether permission was refused and the dye user referred to British dyemakers; whether the British price quoted was £1,736 more for the two tons of dyeware; and whether, in view of the large amount of unemployment caused in the dyeing trade by dear dyewares, he would state what steps he proposed to take to remedy this evil?

Sir Philip Lloyd-Greame replied: The applications to which the hon. member refers were, I understand, made by the British Cotton and Wool Dyers' Association. They were refused by the Dyestuffs Advisory Licensing Committee after full consideration of all the circumstances relating to the particular consignments in question, and I do not propose to take any action in the matter. I am unable to assent to the proposition that the establishment of a dye-making industry in this country is injurious to employment in the dyeing industry. The former is, on the contrary, essential to the security of the latter.

Sir Wilfrid Sugden and other Members asked the President of the Board of Trade whether his attention had been drawn to the description in the press of a method of treating gas by a Mr. Tully, whereby, so it was alleged, the percentage of carbon monoxide was very greatly reduced; and whether he had any information as to the practicability of producing such a gas upon a commercial scale?

Sir Philip Lloyd-Greame said: The latest analysis which I have seen of gas produced by Tully plant at present in industrial use, which was published on the 16th May in the *Gas Journal*, gives the carbon monoxide content as 37 per cent., but I observe that in a prospectus just issued, it is stated that by means of a new converter the carbon monoxide content can be reduced to a negligible quantity. I am not in a position to express an authoritative opinion as to the practicability of producing town gas on a commercial scale by the new process. The matter is, however, being carefully watched by the Government Departments concerned.

Mr. Darbishire asked the President of the Board of Trade if he was aware that it was not with the approval of the Colour Users' Association that the distribution of reparation dyestuffs was transferred from the *Central Importing Agency* to the British Dyestuffs Corporation, and that on many occasions the prices of reparations dyes was *more than the prices at which they could* be obtained from Germany under licence; and if he would consider the advisability of *removing all restrictions upon the free import* of foreign dyestuffs?

Viscount Wolmer, Under-Secretary to the Board of Trade, replied: In answer to the first part of the question, the Chairman

of the Colour Users' Association has publicly expressed (the last occasion being on the 14th April) the Association's appreciation of the manner in which the distribution of reparation dyestuffs has been handled by the British Dyestuffs Corporation. As regards the second part, an advisory committee on prices has been formed, on which two out of the four members are representatives of the Colour Users' Association. The answer to the last part of the question is in the negative.

NOTES ON THE ESTIMATION OF TUNGSTEN IN ORES.

By J. R. Pound, M.Sc.

The following notes sum up the writer's experience, which extended over a very busy period of some three years, dealing with wolfram ores and concentrates. The three methods for the estimation of tungsten that are discussed below are well known, but these results of their trials and comparison under technical conditions may be interesting.

Method 1.—The routine procedure for the assay of rich wolfram ores or concentrates was as follows:—Take 1 gram of finely-ground sample; digest with HCl and HNO_3 for about 2 hours, evaporating down to *near* dryness. To the remaining 5 cc., say, of liquid, add water, warm or boil for ¼ to ½ hour, filter through a small filter paper, and wash the beaker and the insoluble matter (WO_3, SiO_2, etc.) in the beaker at this stage. Then place a weighed porcelain dish under the filter funnel and wash the beaker and the filter paper with successive small quantities of strong NH_4OH, finally bringing all the insoluble matter on to the filter paper, and collecting the ammoniacal filtrates in the porcelain dish. Then place the filter paper with the insoluble matter in a porcelain crucible, dry and burn off the paper, cool, and brush the contents of the crucible on to an agate mortar, grind it to flour, and brush this back to the original beaker without loss. In the absence of draughts this can be done safely. Re-treat this residue with acid and ammonia as above, running the second ammoniacal filtrate into the previous porcelain dish, which in the meantime has been heating on a water-bath. Finally evaporate to dryness on the water-bath the combined ammoniacal filtrate, and then heat gradually to a red heat over a Bunsen burner, cool, and weigh. Then the contents of the porcelain dish give the WO_3 (tungstic acid) directly.

The final filter paper and insoluble matter may be ignited in a porcelain crucible, thus giving the "insoluble matter." If the ore is only wolfram with insoluble matter, which is often the case, then

$$(\text{per cent. } WO_3 \times \frac{4}{3} + \text{per cent. insol.})$$

should reach 100 per cent., and this is sometimes a useful check. Pure wolfram FeMn) WO_4, contains about 76 per cent. WO_3. Some authorities quote a maximum value of 76.6 per cent. WO_3, but the Tasmanian wolfram best known to the writer contained at the most 75.8 per cent. WO_3.

Notes on Method 1.—(1) The attack of HCl or aqua regia on wolfram produces the insoluble WO_3, and thus the action is slow, and the last portion of the wolfram is liable to be protected from decomposition. Fine grinding is essential, therefore, and especially for material containing over 38 per cent. of WO_3—*i.e.*, over 50 per cent. of wolfram. The actual assay sample of such material must be ground to flour in an agate mortar. This is easier said than done. Also, during the acid treatment the sample is liable to "crust up" and thus to protect thte lower layers from the action; this crust should be broken up several times during the action. When products containing less than 50 per cent. wolfram are ground, and the wolfram is the softest constituent, then a ground product is easily obtained in which all the wolfram is fine enough to be completely and readily decomposed by acids; and if the other constituents of the ore are insoluble in the acids, their presence keeps the wolfram particles separated, and considerably helps the complete decomposition of the wolfram, and in this case the second acid and ammonia treatment is unnecessary. Such common constituents of wolfram ores are silica, silicates, and cassiterite.

(2) The writer could see little if any advantage accruing from prolonged action of HCl alone; therefore, after treatment with HCl for about ¼ hour the HNO_3 was added and the solution slowly evaporated down. The usual amounts of acids were about 40 cc. HCl and 5 cc. HNO_3, and the time of treatment would vary from 1 to 3 hours. It is doubtful if prolonged action of acid is worth the time—*i.e.*, probably the bulk of the wolfram is decomposed within an hour.

The second acid treatment, necessitated by the imperfect grinding or the incomplete decomposition in the first case, is completed in a short time — say, ½ hour. Evaporation of the acid right to dryness is liable to render the WO_3 difficultly soluble in ammonia.

(3) It is necessary to wash the WO_3 on the filter paper with strong ammonia, otherwise colloidal silica will run through and ultimately be weighed as WO_3. It is not necessary to add ammonium chloride to the ammonia wash liquor, and the presence of excessive ammonium chloride with the ammonium tungstate in the porcelain dish causes the contents to flake and jump off the dish during the ignition, thus producing mechanical loss of WO_3. The ammonia washing of the WO_3 sometimes becomes slow; possibly the silica (or silicic acid) clogs the pores of the filter paper. It is thus best to bring the bulk of the insoluble matter on to the filter paper only with the last ammonia washes. The ammonia filtrate should fit comfortably in an 80-cc. porcelain dish.

(4) The use of a water bath is recommended, as the ammoniacal liquor then evaporates to dryness quietly and safely, and needs no watching.

(5) In this method there is a tendency for colloidal silica to run through with the ammonia liquor, but this may be kept at a minimum by the conditions described under note (3). If the ammoniacal filtrates are collected in a platinum dish the SiO_2 may be removed by the usual H_2SO_4 and HF treatment, and this treatment might be necessary for low-grade material containing easily decomposable silicates; it was not adopted in the work covered by these notes.

The filtrate ater the first acid treatment can be tested, after dilution, with H_2S, and thus CuS, Bi_2S_3, *etc.*, can be precipitated and qualitatively and quantitatively estimated, and afterwards, of course, other constituents of the ore—*e.g.*, the calcium from scheelite, $CaWO_4$—can be detected and estimated in the usual way.

The final insoluble matter may be inspected for silica or rock minerals (white), titaniferous iron ore (black), and especially for cassiterite (after the acid treatment, brownish). Such an inspection, after a little experience, will enable the tin content of the wolfram concentrates to be estimated to the nearest per cent., especially when the amount is small—say less than 5 per cent. Sn. In any case the tin content of the sample may be obtained with accuracy by Pearce's method applied to this insoluble matter—i.e., by fusing it with Na_2O_2, dissolving the melt in HCl, reducing the strongly-acid hot solution with nickel, cooling in CO_2, and diluting and titrating the $SnCl_2$ solution with an iodine solution which has been standardised similarly against pure metallic tin. The writer found this to be the most satisfactory method of estimating the tin in all cassiterite-wolfram concentrates.

When dealing with or purchasing various and unfamiliar wolfram concentrates, the above acid method thus enables the other constituents to be detected and estimated, if necessary, with the minimum of trouble, and this is an important feature. Nevertheless, as will be seen later, with concentrates rich in wolfram care is necessary to avoid low results for the tungstic acid content, and in general the higher of two duplicates will give the more correct per cent. WO_3. The common tendency is for some of the wolfram to remain unattacked or for some of the WO_3 to remain occluded as ammonium tungstate in the filter paper. In the latter case the yellow WO_3 will be seen in the final ignited insoluble matter. By this method duplicate results should agree to within 1 per cent. of the wolfram content of the sample.

Method 2.—A modification of the above method, which obviates the last-mentioned source of error, is to grind perfectly at the start so as to ensure complete decomposition of the ore in one acid treatment, and, after washing the WO_3 free from acid, to place it, filter paper and all, in AmOH solution in a graduated flask or beaker (the original beaker may serve), and after its dissolution as ammonium tungstate to make up to the definite volume, and then to take of the clear supernatant liquid a definite aliquot part, which, on evaporation to dryness and ignition, gives the WO_3, and hence the per cent. WO_3 of the sample is calculated. This method does not necessarily demand complete disintegration of the ore in one acid treatment, but such would be advisable. Excepting that the remaining insoluble matter is not directly

collected, this modified acid method is perhaps better than the previous one—*i.e.*, it is inclined to give higher results for the per cent. WO_3.

Method 3.—The writer also used the well-known mercurous nitrate method of estimating tungsten, and by this means correct results may be obtained. This method was carried out as follows:—Take ½ gram of wolfram concentrates and fuse with NaOH in a nickel dish for 15 minutes; then dissolve the melt in hot water, a little Na_2O_2 being added, and then filter hot from the insoluble Fe and Mn oxides, unattacked SnO_2, etc., and wash well with hot water. Then slightly acidify the filtrate with HNO_3, heat till the CO_2 escapes and the separated silicic acid (and stannic acid) is coagulated, and then make alkaline with ammonia, heat and filter, and wash. Again slightly acidify the filtrate with HNO and precipitate the tungsten as mercurous tungstate, Hg_2WO_4, a pale yellow coagulable precipitate, by the addition of $Hg_2(NO_3)_2$ solution. This last step demands a nearly neutral solution, but as the $Hg_2(NO_3)_2$ solution can only be made with excess HNO_3, the assay solution becomes more acid during the precipitation; small excess of $Hg_2(NO_3)_2$ is added and then dilute AmOH drop by drop till the liquor is neutral or slightly acid, when all the tungsten is precipitated as Hg_2WO_4, along with more or less black Hg and mercury amino-compounds. As Hg_2WO_4 is soluble (with decomposition) in excess of AmOH or of HNO_3, the conditions of precipitation must be carefully observed, otherwise it is possible to leave tungsten in the solution. The tungsten bearing precipitate is well washed with hot water containing a little $Hg_2(NO_3)_2$, the precipitate is dried, placed in a porcelain crucible, and ignited, and the resulting WO_3 is weighed.

This is probably, when combined with suitable modifications (*vide* note "5" above), the most accurate method of separation of the tungsten from all other constituents of most wolfram ores, *e.g.*—SiO_2, SnO_2, Nb, and Ta; but it is not suitable for scheelite or for ores containing Ca and similar metals, appreciable metallic sulphides, especially arsenical pyrites, or phosphates, in which cases the acid method is preferable. In the $Hg_2(NO_3)_2$ method the "fiddling about" necessary to ensure the complete precipitation of the wolfram takes time, and also the other constituents of the original ore are not separated in a form in which they can be readily detected or estimated, and finally this method is rather expensive. These facts, and the almost general adoption of the acid method by others (buyers or sellers), led to the restricted use of the $Hg_2(NO_3)_2$ method.

The following table will indicate some results on wolfram ores or concentrates obtained by means of these three methods. The figures quoted are in all cases the means of duplicates. The results by methods (1) and (3) were obtained by the writer on the same bulk assay sample; the results by method (2) were obtained by an independent assayer on his own sample, and thus between (1) or (3) and (2) there is a possible divergence due to the two samplings, but as these were carried out on approximately 5-ton parcels of the fine material (minus 6 mesh), shipped in bags of 1 cwt. capacity, the possible errors of sampling should be very small.

Percentage weight of tungstic acid (WO_3) in wolfram ores as determined by—

—	(1) The stock acid method.	(2) The modified acid method.	(3) The $Hg_2(NO_3)_2$ method.
	p.c. WO_3	p.c. WO_3	p.c. WO_3
(*a*)	71.3	72.4	72.6
(*b*)	68.8	69.6	69.8
(*c*)	67.3	67.1	67.4
(*d*)	68.2	—	68.1
(*e*)	59.2	—	59.5
(*f*)	71.3	—	72.4
(*g*)	—	71.5	72.4
(*h*)	64.6	65.3	—

It will be seen that method (1) tends to give the lowest results, which occasionally are below those of methods (2) and (3) by more than desirable limits, which may be placed at 0.6 per cent. WO_3 on this class of material, *e.g.*—(*a*), (*b*), and (*f*). Method (2) agrees well with method (3), but the latter method inclines to give the higher results. It need only be stated, in conclusion, that the above results represent average results obtained in the writer's practice.

(*From the Proceedings of the Australasian Institute of Mining and Metallurgy*, Sept., 1922, pp. 291-6.)

NOTICES OF BOOKS.

Theoretical Chemistry, by PROF. W. NERNST, PH.D. Revised in accordance with the eighth-tenth German edition by L. W. CODD, M.A. Pp. XX. + 992. *London: Macmillan & Co., Ltd.*, St. Martin's Street, W.C. 1923. Price 28s. net.

The English translation of Prof. Nernst's well-known volume on Theoretical Physical Chemistry has now reached its fifth edition.

The important advances in physics and chemistry made since the appearance of the previous edition, some seven years ago, have necessitated additions and alterations in some chapters. That on *Radioactivity* has been re-written, and recent work on the *Atom* and in X-ray Spectroscopy has been incorporated.

One or two minor but obvious slips have been noted. These do not detract from the great value of this important work.

The Examination of Hydrocarbon Oils, and of Saponifiable Fats and Waxes, by PROF. DR. D. HOLDE. Authorised translation from the fifth German edition by EDWARD MUELLER, PH.D. Second English edition. Pp. XIX. + 572. London: Messrs. Chapman & Hall, 11, Henrietta Street, W.C. 1922. Price 30s. net.

This second English edition, which brings Prof. Holde's valuable technological work up-to-date and available for English readers, has been based upon the fifth German edition, which appeared soon after the conclusion of the war. It therefore contains much new matter. Some of this has been commendably well condensed into tables, where this mode of treatment was possible.

Of the other new matter, English scientists and chemists will be perhaps most interested in the many revelations of the extremities to which German industry was driven towards the close of the war by the lack of fats and oils. Hydrolysis of fats for soap production was forbidden, and oils of any use for food could not be used for varnishes, etc. Every possible source of fat, including such remote material as grape seeds and beech nuts, was exploited.

The general subject, as indicated in the title, is very fully covered, and there is a mass of information upon those points for which a book of this kind would be consulted. It should prove of great value to technical and analytical chemists.

BOOKS RECEIVED.

Experimental Researches and Reports, by DEPARTMENT OF GLASS TECHNOLOGY. Pp. 138. Vol. V. 1922. Department of Glass Technology, The University, Sheffield.

Klinische Kolloidchemie, by DR. ERNST JOEL, MIT EINEM GELEITWORT VON PROF. DR. K. SPIRO. Pp. 124. 1923. Von Theodor Steinkopff, Dresden und Leipzig. 2s. 2d.

PUBLICATIONS RECEIVED.

The U.S. Department of the Interior have issued the following bulletins:—

Bulletin 686: *Structure and Oil and Gas Resources of the Osage Reservation, Oklahoma, and Structure Maps*, by DAVID WHITE and others. Pp. 427.

Bulletin 736-H.: *Stratigraphy of the El Dorado Oil Field, Arkansas, as determined by Drill Cuttings*, by JAMES GILLULY and K. C. HEALD. Pp. 8 + VI.

Bulletin 480: *Surface Water Supply of the United States*, 1918. *Part X.—The Great Basin*. Pp. 271.

Bulletin 483: *Surface Water Supply of the United States*, 1918. *Part XII.—North Pacific Drainage Basins. B. Snake River Basin*. Pp. 171.

Bulletin 508: *Surface Water Supply of the United States*, 1919-1920. *Part VIII.—Western Gulf of Mexico Basins*, by NATHAN C. GROVER and C. E. ELLSWORTH. Pp. 186.

Gold, Silver, Copper, Lead and Zinc in Nevada in 1921. *Mines Report*, by C. C. HEIKES.

Gold, Silver, Copper, Lead and Zinc in Idaho and Washington in 1921. *Mines Report*, by C. N. GERRY.

Mineral Waters in 1921, by W. D. Collins.

Gold, Silver, Copper, Lead, and Zinc in New Mexico and Texas in 1921. *Mines Report*, by Charles W. Henderson. Pp. 467-477.

Gold, Silver, Copper, Lead and Zinc in Colorado in 1921. *Mines Report*, by Charles W. Henderson. Pp. 479-511.

Economic Geology of the Summerfield and Woodsfield Quadrangles, Ohio, with descriptions of Coal and other Mineral Resources except Oil and Gas, by D. Dale Condit. Pp. 156.

Manganese Deposits of East Tennessee, by G. W. Stose and F. C. Schrader. Pp. X., 154.

Metal-Mine Fires, by Daniel Harrington, Byron O. Pickard, and H. M. Wolflin.

Quarry Accidents in the United States during the Calendar Year 1921, by William W. Adams.

Talc and Soapstone—Their Mining, Milling, Products and Uses, by Raymond B. Ladoo.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

12999—Compagnie de Bethune.—Manufacture of sulphovinic acid from ethylene. May 15.

13364—Goldschmidt Akt-Ges., T.—Production of silicon-containing aluminium alloys. May 18.

12969—Indurit Products Co., Ltd.—Production of articles of the phenol formaldehyde condensation product type. May 15.

13246—Soc. of Chemical Industry in Basle.—Manufacture of intermediate products for azo dyestuffs. May 17.

Specifications Published this Week.

171684—Simonson, W. H., & Mantius, O.—Process for reclaiming sludge acid in petroleum refining.

196993—Atack, F. W.—Process for sulphurising organic compounds.

186572—Lefranc et Cie.—Process for the manufacture of butyric acid and other fatty acids with recovery of the gases of fermentation.

197061—Wolvekamp, M. E.—Colloidal compounds of antimony sulphide.

197060—Wolvekamp, M. E.—Soluble preparations of colloidal sulpharsenites.

197223—Baumgartner, E.—Manufacture of chromate of soda.

189432—Farbwerke Vorm. Meister Lucius & Bruning.—Manufacture of formaldehyde.

Abstract Published this Week.

195444—Process for reduction of grain.—Chemical Eng. Co. (Manchester), Ltd., & Spensley, J. W., 49, Deansgate, Manchester.

Grain is reduced by treatment in a combination of break rolls, or other ordinary milling *appliances, with high-speed centrifugal pin-disc* mills. The grain may be subjected to lighter treatment in the earlier break rolls and the final tailings, consisting mainly of bran, are then treated in a pin-disc mill to obtain a further yield of flour. Or fewer sets of break rolls may be employed. The earlier break rolls, except the first, may be replaced by pin-disc mills which are run at a lower speed. The air blast produced by the disc mills may be utilised to perform a preliminary separation of the product.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

195295—*Alumina.—Pedemonte, A. L.*, 2, Rue Emile-Zola, Toulon, France.

Alumina; aluminium chloride and sulphide.—Pure alumina is obtained from ferruginous bauxite by heating in a reducing atmosphere to render the iron and titanium magnetic, separating these impurities by magnetic action, dissolving the purified bauxite in hydrochloric or sulphuric acid, digesting to render silica and any remaining titanium insoluble, filtering, and evaporating the filtrate to dryness and calcining the aluminium salt to obtain alumina and recover the acid.

THE CHEMICAL NEWS,
VOL. CXXVI. No. 3297.

A NOTE ON THE ATOMIC WEIGHT OF TITANIUM.

By F. H. Loring.

In the *Journal of the American Chemical Society* for May 1923, p. 1228, G. P. Baxter and G. J. Fertig announce in a preliminary paper a new determination of the atomic weight of titanium by the analysis of titanium tetrachloride. The value obtained from an average of four fairly concordant analyses is 47.88, which may be rounded off to 47.9. The present but older value obtained by Thorpe is 48.1. The mean of the values = 47.99.

In this Journal (1920, CXXI., 105), the present writer developed a scheme for evaluating certain atomic weights based upon the existence of certain isotopes, but the calculated atomic weight of titanium was incident upon hypothetical isotopes 48 and 50. They may be 48 and 46, as the following calculation will show.

If the starting values in the scheme are $11 \times 4+4 = 48$ and $11 \times 4+2 = 46$, then the calculation becomes: $(4^3 \times 48+2^1 \times 46)/(4^3+2^1)$, and the value, which is a mean one, comes out 47.94. The *a, b, c, d*, values, 1, 2, 3, 4, respectively, have either to be raised to the third or first powers. In this case $4^3=64$ and $2^1=2$, obviously, as previously indicated in principle, with satisfactory results in some instances; *e.g.*, nickel, which involved 2^3 and 4^1.

THE ELECTROMETRIC TITRATION OF MOLYBDENUM WITH A TITANOUS SALT.

By H. H. Willard and Florence Fenwick.
[*Contribution from the Chemical Laboratory of the University of Michigan.*]

Introduction.

The reduction of molybdic acid to a salt of pentavalent molybdenum by means of trivalent titanium was observed by Knecht and Hibbert.[1] They failed in the attempt to base a volumetric method for the determination of molybdenum upon this fact because of the lack of a suitable indicator for the end-point. An investigation of the applicability of the electrometric titration showed that the reaction is sufficiently rapid for this to be used. The character of the end-point with the polarised bimetallic electrode system with platinum electrodes is essentially as has been described for other titrations.[2] After enough of the titrating solution has been added for equilibrium to be established, there is practically no further change until within about 0.5 cc. of the end-point. The potential difference increases slightly, decreasing again on the addition of excess titanium. Normally the maximum is perfectly definite when the titration is carried out slowly as the end is approached so that equilibrium may be maintained. Otherwise a transient and irregular decrease in e.m.f. may occur before the reaction is quite complete. It is safest to add several drops more of the titanous solution after the supposed end-point has been reached to insure that the potential decrease is permanent and increasing. The reduction is not ideally fast. For this reason it is probable that a better end-point would be obtained with the usual monometallic electrode system. This point was not investigated.

The acid concentration of the molybdenum solution is an important factor; 5-10 per cent. by volume of conc. hydrochloric acid is the most desirable; too high a concentration weakens the reducing power of trivalent titanium appreciably. Sulphuric acid is unsatisfactory. Heat increases the velocity of the reaction but is unnecessary except in special cases.

Titration of Sodium Molybdate with Titanous Sulphate.

An approximately 0.017 *M* solution of C. P. sodium molybdate was titrated with titanous sulphate[3] standardised by the method of Thornton and Chapman[4] against ferric sulphate prepared from electrolytic iron of known purity.

[1] *Knecht and Hibbert, "New Reduction Methods in Volumetric Analysis," Longmans, Green and Co.*, 1918, p. 99.

[2] *Williard and Fenwick, Jour. Amer. Chem. Soc.*, 1922, XLIV., 2516.

[3] *Prepared by the electrolytic reduction of titanic sulphate and stored in an atmosphere of hydrogen.*

[4] *Thornton and Chapman, Jour. Amer. Chem. Soc.*, 1921, XLIII., 91.

Table I.

TITRATION OF PURE SODIUM MOLYBDATE WITH TITANOUS SULPHATE.

The solutions contained about 8 per cent. by volume of conc. HCl and were heated to about 80°. 0.05 *N* Ti factor against Fe, 1.4002.

0.017 *M* Na_2MoO_4 taken	0.05 *N* $Ti_2(SO_4)_3$ req.
5.00	2.17
10.00	3.92
15.00	5.61
20.00	7.42

A finite excess of the titanous solution is required over that theoretically necessary for a reduction to the pentavalent state. This excess must be independent of the total amount of molybdenum present, and may be determined by titrating solutions of varying molybdenum content and solving the equation, $n(a-x) = (b-x)$, where *a* and *b* are the number of cubic centimetres of the titrating solution required for 2 solutions of known molybdenum content, *x* is the required excess, and *n* the ratio of the weight of molybdenum in Solution *b* to that in Solution *a*.

Using the given formula, the excess of titanous solution required to give the end-point was determined from the data in Table I. By combining Expt. 1 with Expts 2, 3, 4, *x* was found to be 0.42. 0.45, 0.42 cc., respectively; by combining Expt. 3 with Expt. 4, 0.18 cc. was obtained. The value of *x* is to some extent a function of the electrode system used and the magnitude of the polarising voltage. For the most accurate results the titanium solution should be standardised against a molybdenum solution of known strength, using a volume of the titrating solution as nearly as possible equal to that required for the unknown. It was concluded from the results of a considerable number of titrations that an accuracy greater than 0.1 cc. of 0.05 *N* solution, which is the equivalent of 0.48 mg. of molybdenum, cannot be claimed for the method.

TITRATION OF MOLYBDENUM IN AMMONIUM PHOSPHOMOLYBDATE.

The titration of the molybdenum in a precipitate of ammonium phosphomolybdate is an excellent method of determining the phosphorus content of steels. No special refinements are necessary in standardising the titanous solution for this purpose, since 37.11 mg. of molybdenum corresponds to 1 mg. of phosphorus, and the effect of any slight error in the titration falls far below the limit of accuracy of the precipitation.

After precipitation of the phosphorus in the usual way[5] the ammonium phosphomolybdate is dissolved in ammonia, filtered to remove any iron, and the acidified solution titrated with titanous sulphate. If the precipitate is very large it tends to reprecipitate upon the addition of acid. This may be prevented by the addition of a few drops of phosphoric acid to the ammoniacal solution, but the character of the end-point is thereby altered. In the cold there is no voltage drop with excess of the titrating solution. Just preceding the end-point the normal rise begins, ceases, then continues with increased velocity just as the equivalent point is passed. If the solution

[5] Scott, "*Standard Methods of Chemical Analysis*," D. *Van Nostrand Company*, *3rd Edition*, 1922, p. 365.

Table II.

DETERMINATION OF PHOSPHORUS IN STEEL.

Steel	Sample G.	H_3PO_4 Sp. gr. 1.7 Cc.	Ti^{+++} req. Cc.	% P from Mo factor	% P from Fe factor	% P Certificate value
0.4 C	2.000	1	9.37	0.1016	0.1027	0.102
Bessemer	2.001	0	9.57	0.1016	0.1028	...
0.1 C	5.003	1	7.20	0.0312	0.0316	
B. O. H.	5.002	0	7.22	0.0313	0.0316	0.031
	5.004	0	7.30	0.0316	0.0320	
0.1 C	2.003	0.5	10.31	0.1116	...	0.112
Bessemer	2.001	0.5	10.29	0.1100	...	

is titrated hot, however, the end-point is perfectly normal and as distinct as in the absence of the phosphoric acid. The separation of titanic phosphate sometimes occurs but has no effect upon the sharpness of the end-point.

Three Bureau of Standards steels were analysed by this method; the results are shown in Table II. The 0.05 *N* factor of the titanium solution against molybdenum was 1.6765; against iron, 1.6956.

The colour of the reduced solution is an extremely intense bluish purple, and forms an excellent qualitative test for molybdenum, even in amounts less than 1 mg. in the absence of tungsten and vanadium.

EFFECT OF TUNGSTEN.

One of the most interesting points in connection with the molybdenum titration is the non-interference of tungsten even when present in large amounts. If anything, the end-point is rendered more distinct. Certainly, results seem to be more uniform. There is greater necessity for proceeding slowly near the completion of the titration than when no tungstic acid is present. Very transient decreases in potential occur near the end-point as the titrating solution is added drop by drop, but cease just before the reaction is complete, and the permanent end-point drop is very distinct. The colour is as characteristic as that of the complex phosphate, and is due to an intense blue-black, finely divided precipitate or a solution in case phosphoric acid is also present.

Various amounts of tungsten, in the form of a solution of pure sodium tungstate, were added to 15.00 cc. samples of sodium bolybdate, and the molybdenum was titrated. The molybdate was standardised gravimetrically[6]; the 0.05 *N* factor was 1.0005. The titanous solution was standardised against iron; 0.05 *N* factor, 1.2904. All samples contained about 5 per cent. of conc. hydrochloric acid and were titrated cold.

Table III.

EFFECT OF TUNGSTEN.

0.05 *M* $Na_2WO_4.2H_2O$ added	0.05 *N* $Ti_2(SO_4)_3$ req.
Cc.	Cc.
0	15.38
1	15.10
2	15.07
5	15.02
15	15.08
75	15.06

[6] *Weiser, J. Phys. Chem.*, 1916, XX., 657.

If the calculated excess of titanous solution, 0.40 cc. (p. 980), is subtracted from 15.38 cc. it leaves 14.98 cc. The results obtained in the presence of tungsten are in very fair agreement with this theoretical value.

SEPARATION OF MOLYBDENUM FROM IRON.

Two methods are in general use for the separation of molybdenum from iron prior to the determination of the former element in steels: (1) precipitation of molybdenum as sulphide from slightly acid solution[7] and (2) precipitation of iron as ferric hydroxide by pouring the acid solution into hot sodium hydroxide solution.[8] An attempt was made to use another method based upon the insolubility of lead molybdate in 2 per cent. perchloric acid. This gives a complete separation from chromium and vanadium. If no other strong acids are present precipitation is complete, but iron is always occluded to some extent and must be removed by treatment with sodium hydroxide, thus detracting from the value of the proposed method.

Synthetic steels were prepared from ferric nitrate and a standard solution of sodium molybdate. The calculated amount of 60 per cent. perchloric acid to form ferric perchlorate and 9 g. in excess was added to each of the samples and the solutions were evaporated until fumes were evolved. A partial dehydration of the molybdic acid occurs, but this presents no difficulties. Chromium, if present, is oxidised and lead chromate, which is much less soluble than the molybdate, will later precipitate. After the evaporated samples were dissolved in water the chromic acid was reduced with a slight excess of ferrous perchlorate. The reduced solutions were heated to boiling and the molybdenum was precipitated by slowly adding to the boiling solution[9] a solution of 10 g. of lead

[7] *Johnson, "Chemical Analysis of Special Steels," John Wiley and Sons, 3rd Ed.*, 1920, *p.* 156.

[8] *Ref.* 5, *p.* 314.

[9] *Lead molybdate precipitates immediately and completely in the cold in 5 per cent. perchloric acid in the absence of iron. The latter interferes in the precipitation. With large samples of steel, 2 g. or over, considerable boiling is required for complete precipitation. No precipitation at all occurs in the cold.*

perchlorate.[10] The final volume was 300 cc. After the solutions had stood overnight they were filtered through Gooch crucibles, washed with 2 per cent. perchloric acid, then with water, and the precipitates dissolved in sodium hydroxide. The asbestos and ferric hydroxide were filtered off, the filtrates acidified with a 5 per cent. excess of hydrochloric acid, and titrated with titanous sulphate.

Table IV.

Determination of Molybdenum in Synthetic Steels.

In all experiments 1 g. of iron and 0.0720 g. of molybdenum were added. The latter required theoretically 10.00 cc. of titanous solution. This solution was standardised against the standard molybdate solution.

Cr added	V added	Ti+++ req	Error
Mg.	Mg.	Cc.	Mg. of Mo
0	0	9.95	-0.36
0	0	9.90	-0.72
20	0	10.00	0.0
20	5	9.98	-0.14
20	5	10.00	0.0

Summary.

The reduction of hexavalent molybdenum to the pentavalent state by titanous salts is sufficiently rapid for employment of electrometric titration. This gives a means of determining molybdenum in alkali molybdates accurate to within 0.5 mg. and, indirectly, phosphorus in the precipitate of ammonium phosphomolybdate. Tungstic acid presents no interference, and it also eliminates the necessity of applying a correction for the excess titanous solution required to give the end-point.

Ann Arbor, Michigan.

—(*From the Journal of the American Chemical Society*, 1923, XLV., 928-33.)

[10] *Made by dissolving the theoretical quantity of pure litharge in perchloric acid. The oxide was added slowly to the cold, dilute acid, heated to boiling, cooled and filtered.*

THE ELECTROMETRIC TITRATION OF SELENIUM IN THE PRESENCE OF TELLURIUM, IRON AND COPPER.

By H. H. Willard and Florence Fenwick.

[*Contribution from the Chemical Laboratory of the University of Michigan.*]

Introduction.

The reduction of selenious acid to metal by titanous chloride was observed by Moser[1] and also by Monnier.[2] Moser attempted to develop a volumetric method for selenium based on this reaction, using methylene blue as indicator, but the results obtained were invariably too high. This was due to the further reduction of the selenium to hydrogen selenide, a compound which had been shown to exist under similar conditions by Pleischl[3] and Trautmann.[4]

Under the condition imposed by Moser, namely, a hot hydrochloric acid solution, the electrometric end-point is either absent or very poor, but in a cold solution containing 25 to 75 per cent. of conc. hydrochloric acid and saturated, or nearly so, with sodium chloride, the end-point with the previously described polarised bimetallic electrode system[5] with platinum electrodes is excellent. The presence of the sodium chloride is important. It insures rapid and uniform coagulation of the selenium hydrosol and increases the sharpness of the change in voltage at the end-point. The use of a cold solution also eliminates the almost inevitable loss of selenium by volatilisation.

The character of the end-point for this titration is somewhat difficult to describe but is readily discovered by experiment. After enough of the titrating solution has been added to give a constant potential, there is little change until within a short distance of the end-point. Slight fluctuations in the e.m.f. may be manifested; the resistance of the solution is so low that the galvanometer is extremely sensitive. The characteristic rise occurs, with the fall im-

[1] *Moser, Z., anal. Chem.*, 1918, LVII., 277.

[2] *Monnier, Ann. chim. anal. appl.*, 1915, XX., 1.

[3] *Pleischl, Kastner Arch.*, XCIII., 430.

[4] *Trautmann, Bull. soc. ind. Mülhouse*, 1891, LXI., 87.

[5] *Willard and Fenwick, Jour. Amer. Chem. Soc.*, 1922, XLIV., 2516.

ɪediately following. The condition of the ɔlution with respect to acidity and foreign alts determines which of the two predomiates. Increasing the polarising e.m.f. rom 0.1 to 1.0 volt makes no appreciable ifference in the character of the end-point. As is the case with other titanous titraions, the actual voltage change may not be arge, in fact may not amount to more than ɪ few millivolts. The galvanometer should ɔe sufficiently sensitive to give a distinct leflection for a change in potential of 1 mv. ɔetween the electrodes.

It is inadvisable to clean the electrodes between titrations more than to wash them with distilled water. The small amount of selenium adhering after the first titration increases the sharpness of the end-point. The coagulation of the colloidal selenium in the near vicinity of the end-point is quite distinct, and affords a fairly close visual check on the titration.

Titration of Selenious Acid with Titanous Sulphate.

A pure commercial selenium was dissolved in nitric acid, evaporated to dryness, and the selenium dioxide obtained purified by two sublimations. An approximately 0.05 *N* aqueous solution of selenious acid was prepared and standardised gravimetrically by reduction with hydrazine sulphate according to the method of Gutbier, Metzner and Lohmann.[6] In four experiments the weights of selenium obtained from 100.00 cc. of the solution were 0.0994, 0.0995, 0.0997, 0.0996 g., or an average of 0.0995 g.

The solution was, therefore, 0.0503 *N*. The purity of the selenium dioxide was 99.1 per cent., the rest being, doubtless, moisture.

[6] *Gutbier, Metzner and Lohmann, Z. anorg. Chem.*, 1904, XLI., 297.

Table I.

Titration of Selenious Acid with Titanous Sulphate.

Total initial volume in all cases, 100 cc.

SeO_2 taken Cc.	$Ti_2(SO_3)$ req. Cc.	Av. Cc.	$Ti_2(SO\,)$ Fe factor calc. from Cc.	$Ti_2(SO_3)$ $KMnO_4$ factor calc. from Cc.
10.00	6.85			
10.00	6.75	6.80	6.70	6.72
15.00	10.15			
15.00	10.17			
15.00	10.18	10.15	10.05	10.08
15.00	10.10			
20.00	13.52			
20.00	13.52	13.52	13.40	13.44
30.00	20.15			
30.00	20.26			
30.00	20.15	20.19	20.10	20.16
30.00	20.20			
40.00	26.80			
40.00	26.80	26.80	26.80	26.88

Samples of this solution were titrated electrometrically with titanous sulphate[7] in solutions containing 40 per cent. of conc. hydrochloric acid and saturated with sodium chloride. All titrations were conducted in a current of carbon dioxide. The titanium solution was standardised against a solution of ferric sulphate,[9] prepared from electrolytic iron of known purity, and against potassium permanganate.[10] Against

[7] *Prepared by the electrolytic reduction of titanic sulphate and stored in an atmosphere of hydrogen. Thornton and Chapman, Jour. Amer. Chem. Soc.*, 1921, XLIII., 91.

[9] *Titrated to the disappearance of the colour of ferric thiocyanate. Thornton and Chapman, Ref. 7.*

[10] *Titrated by adding it to the permanganate in sulphuric acid solution. The permanganate was standardised against sodium oxalate from the Bureau of Standards.*

Table II.

Effect of Hydrochloric Acid.

Total initial volume in all cases, 100 cc.

SeO_2 taken Cc.	$Ti_2(SO_4)_3$ required Cc.	Vol. of HCl (Sp. gr. 1.18) in 100 cc. of soln. Cc.	Character of end-point.
15.00	11.44	75	Very good. Fall at end-point not permanent but definite.
15.00	11.40	50	Rise and fall extremely sharp.
15.00	11.42	35	Very good.
30.00	22.77	35	Very good.
15.00	11.43	25	Rise more marked than fall.
30.00	22.70	25	Good.
[illegible]	[illegible]	25	Good.

the former it was found to be 0.0750 *N*, against the latter, 0.0748 *N*.

From a comparison of the volumes of titanous sulphate used in the several determinations it is evident that the excess of the titrating solution required to give the end-point reaction was very close to 0.10 cc. (The titrations with the 40.00 cc. samples were evidently a little low.) When this correction is made, the check with the amount of titanium calculated from the iron factor is usually within 0.02 cc. The titration of the selenious acid proceeds, then, according to the equation: $SeO_2 + 4HCl + 4TiCl_3 = Se + 4TiCl_4 + 2H_2O$. There can be, therefore, no secondary reaction such as found by Moser[1] and no empirical standards are necessary in the determination.

EFFECT OF VARYING THE CONCENTRATION OF HYDROCHLORIC ACID.

The effect of varying the hydrochloric acid concentration is shown in Table II.

An acidity of 25 to 75 cc. of conc. hydrochloric acid in 100 cc. of solution is entirely satisfactory.

EFFECT OF SULPHURIC ACID.

In the preparation of an actual sample of metallic selenium for analysis it is very desirable to avoid the use of hydrochloric acid for removing the nitric acid in which the material is dissolved. In hydrochloric acid solution selenium chloride is appreciably volatile at the boiling point. For this reason the effect of sulphuric acid upon the titration was studied.

Table III.

EFFECT OF SULPHURIC ACID.

15.00 cc. of 0.05 *N* selenious acid solution was used in each titration. The solutions were saturated with sodium chloride and had an initial volume of 100 cc.

$Ti_2(SO_4)_3$ Cc.	Vol. of conc. acid[a] in 100 cc. of soln. Cc.	Character of end-point.
11.37	50 HCl	(Control titration). Rise long and marked, fall slow. Titrated to end of rise.
11.40	50 HCl + 5 H_2SO_4	Not quite as good as the preceding. No permanent fall. Not difficult to determine end-point.
11.40	50 HCl + 10 H_2SO_4	

[a]Refers to HCl, d. 1.18, or to H_2SO_4, d. 1.84.

The acid may be present in amounts up to 5 or 10 cc. per 100 cc. of solution, but is to be avoided in any considerable quantity.

The non-volatility of selenium in hot sulphuric acid was shown by the evaporation of samples of the selenium solution with 5 cc. of conc. sulphuric acid until dense fumes formed and then titration after the addition of sodium chloride and hydrochloric acid. The maximum variation was 0.06 mg. in a total of 15 mg., or 0.4 per cent. The end-point, however, was not quite as sharp as when the fuming had been omitted.

EFFECT OF TELLURIUM.

Of the common associates of selenium, tellurium is probably of the greatest interest in its effect upon the titration of the former element. In a hot hydrochloric acid solution of moderate concentration tellurium is rapidly reduced by titanous salts, but in the cold the reduction, if any takes place, is very slow.

Metallic tellurium was carefully freed from selenium by Keller's method,[11] reprecipitated as metal, again dissolved in nitric acid, evaporated to fumes of sulphuric acid and dissolved in hydrochloric acid. Various amounts of this solution were added to known amounts of selenious acid solution and determinations made as outlined in Table IV.

[11] *Keller, Jour. Amer. Chem. Soc.*, 1897, XIX., 771. *Scott, "Standard Methods of Chemical Analysis," D. Van Nostrand Company*, 3rd ed., 1922, p. 423.

Table IV.

EFFECT OF TELLURIUM.

15.00 cc. of 0.05 N selenious acid was used in each titration. Total initial volume 100 cc.

Ratio, wt. Te : wt. Se	$Ti_2(SO_4)_3$ Cc.	Vol. of HCl (Sp. gr. 1.18) in 100 cc. of soln.	Character of end-point.
...	11.34	50	(Control titration)
4:5	11.33	50	Sharp rise, no fall with excess
4:5	11.35	50	Regular fall with excess
8:3	11.35	50	Distinct rise, no fall with excess
4:1	11.35	50	No fall with excess
8:1	11.35	50	No fall
8:1	11.30	25	A fall
8:1	11.35	25	A fall
8:1	11.35	25	No fall. End-point a change in rate of rise

Tellurium even in large amounts does not interfere in the titration of selenium, but it seems to affect the character of the end-point much as does sulphuric acid. The fall in potential as the end-point is passed does not always occur, but the rise is fully as sharp as in the absence of these substances. There is no difficulty in recognising the completion of the reaction.

EFFECT OF IRON.

One of the most surprising and interesting things in connection with the selenium determination is the fact that the volume of titanium solution used in titrating mixtures of selenium and ferric iron is identical *with that for the selenium alone, although* ferrous iron is formed during the precipitation. The character of the end-point is much the same as that described later with mixtures of selenium and copper, but no second end-point is obtainable at the point of complete reduction of both elements.

In Table V. the solutions contained 30.00 cc. of conc. hydrochloric acid in a volume of 100 cc. and were saturated with sodium chloride.

The behaviour of selenium under these conditions seemed at first paradoxical. It was observed, however, that with large amounts of iron the precipitation was apparently incomplete. From two samples, one of which contained twice as much ferric iron as the other, the selenium was filtered at the end of the titration, thiocyanate was added, and more of the titanous solution *run in. No sharp colour change occurred.* The deep red faded slowly only to reappear in a few seconds. The amount of titanium required for an approximate end-point was twice as much in the solution containing

Table V.

EFFECT OF IRON.

SeO_2 taken Cc.	0.05 N Fe^{+++} added Cc.	Ti^{+++} req. Cc.	Remarks.
15.00	...	10.60	
15.00	1	10.58	
15.00	5	10.52	
15.00	10	10.61	
30.00	1	21.25	
30.00	10	21.26	
		Second Series.	
15.00	...	10.15	
15.00	25	10.22	Pptn. very incomplete
15.00	35	10.17	Pptn. very incomplete
15.00	50	10.15	Pptn. slight
30.00	50	20.20	Pptn. greater than preceding
10.00	75	6.82	No pptn. End-point a little slow.

double the amount of iron. After much more titanous sulphate had been added there was a further precipitation of selenium. It appeared that ferric iron and selenious acid might form a rather unstable compound in which the selenium is reduced only with difficulty, requiring a large excess of titanium. An amount of ferric iron equivalent to the combined selenium is reduced along with the free selenious acid and the numerical result of the titration, therefore, is unaffected. In the second series the amount of iron was increased until no precipitation occurred, without affecting the results, thus supporting this view. The exact composition of the compound was not investigated.

Effect of Copper.

In hydrochloric acid solution trivalent titanium reduces cupric salts to the cuprous form.[12] When present with selenium, however, the latter is reduced first and apparently selectively. The electrometric titration gives two end-points, one when the selenium is entirely precipitated and a second at the completion of the reduction of the copper. Toward the end of the first reaction the voltage starts to rise slightly. There is then a long, distinct, upward swing that marks the end-point, followed usually by continued rise. The copper end-point is a second sharp rise.[13] It is not quite as clea ras the first but readily distinguishable after a little experience.

Table VI. records a number of titrations carried out in the presence of copper.

[12] *Rhead, J. Chem. Soc.*, 1906, LXXXIX., 1491. *Knecht and Hibbert, "New Reduction Methods in Volumetric Analysis," Longmans, Green and Co.*, 1918. *Moser, Chem.-Ztg.*, 1912, XXXIV., 1126. *Monnier, Ann. chim. anal.*, 1916, XXI., 109. *Mach and Lederle, Landw. Vers. Sta.*, 1917, XC., 191. *Thornton, Jour. Amer. Chem. Soc.*, 1922, XLIV., 998.

[13] *It is obvious that the method may be adapted to the determination of copper alone. A number of very accurate titrations were made in this way, but this application is not stressed because of the rather large amount of other work on this reaction already published.*

Table VI.

Effect of Copper.

All solutions titrated had an initial volume of 100 cc., contained 30-40 p.c. of conc. hydrochloric acid and were saturated with sodium chloride.

SeO_2 taken Cc.	0.05 N $CuSO_4$ added Cc.	Ti+++ req. for Se end-point Cc.	Total Ti+++ used Cc.	Ti+++ req. for Cu Cc.
...	5.00	...	...	3.55
15.00	...	10.50	...	...
15.00	...	10.50	...	...
15.00	5.00	10.53	14.02	3.49
15.00	10.00	10.50	17.60	7.10
15.00	1.00	10.52	...	...
Second Series.				
15.00	...	10.65	...	...
15.00	5.00	10.65	...	...
30.00	5.00	21.24	...	...

Summary.

1. The volumetric reduction of selenious acid to selenium by titanous sulphate is rapid and accurate to within 0.1 mg. in cold hydrochloric acid solution saturated with sodium chloride.

2. Under these conditions tellurium is not reduced, and its only effect is to modify the nature of the end-point.

3. Moderate amounts of sulphuric acid have no deleterious effect upon the determination of the end-point and there is no

volatilisation of selenium at the fuming temperature in this acid.

4. The titration of selenium is quantitatively independent of the concentration of iron, although ferrous iron is formed in the reaction.

5. The reducing effect of trivalent titanium upon mixtures containing copper and selenium is selective, the latter being reduced first, and both elements may be determined in a single titration.

Ann Arbor, Michigan.

—(*From the Journal of the American Chemical Society*, 1923, XLV., 933-9.)

GENERAL NOTES.

NEW COLOUR INDEX.

Notable British Achievement in Dye Technology.

Dye-Users' Vade Mecum.

The new "Colour Index," now approaching completion, will add greatly to the prestige of the British dye industry, and at the same time represent one of the most valuable achievements of the Society of Dyers and Colourists. That there should be a thoroughly up-to-date and comprehensive index of dyes is extremely desirable, but up to the present the best available authority has been a German pre-war publication, now inevitably far from complete. Great Britain has the distinction of having produced what has already been accepted by colour manufacturers, dye-users and technological experts throughout the world as a standard work of supreme importance.

Old Dyes with New Names.

The stoppage of German supplies of dyes during the war led to the rapid development of existing colour works in other countries and the establishment of important new works. Great strides have thus been made in the production of dyestuffs, and many firms are placing on the market dyes which have new commercial names, but which may not be new in constitution. A number of them are replicas of the German products with which users had become familiar. In the absence of definite knowledge as to their constitution, the dye-user has been at a disadvantage in selecting his dyestuffs, and has been bewildered by the multiplicity of products submitted to him.

From a dye-user's point of view, therefore, it is a matter of great importance to know all the different commercial names used to denote the particular dye he requires, and the firms who make such products. No such information has been available, for the most comprehensive work of reference on the subject was the *Farbstofftabellen* of Dr. Gustav Schultz, published in 1914, which necessarily lacks information with regard to the great developments which have taken place in this and other countries during the past nine years.

In order to remedy this defect, the Society of Dyers and Colourists, whose headquarters are at Bradford, decided to undertake the work of compiling an up-to-date and comprehensive Colour Index. The arduous work of editorship was placed in the hands of Dr. F. M. Rowe, of the Manchester College of Technology, assisted by Mr. C. Lea, and a Revision Committee was formed under the chairmanship of Mr. Ernest Hickson, of Bradford, on which the leading dyestuff manufacturers and dyestuff users of all classes were represented, as well as the leading professors and experts on the technical side.

To be Finished this Year.

The Colour Index has been published in monthly parts, the first being issued in September, 1922. In order to ensure the greatest possible accuracy, 150 copies of the proofs of each part are circulated all over the world to colour manufacturers, colour users, and technical experts, and the corrections and suggestions thus embodied have been exceedingly valuable. Fourteen parts are required to complete the Index. The ninth has been issued, and the matter for the remaining parts is now in the hands of the printers. The end of this great undertaking, therefore, is now within sight, and there is no doubt that the remaining five parts will be published before the end of 1923.

Scope of the Work.

One of the features of the Index, when completed, will be the comprehensive indices which it will contain. These will cover the names of many thousands of commercial dyes, and will also deal with the patent numbers, the intermediate products used, and so on. Some idea of the magnitude of the undertaking may be gained from the fact that the number of distinct synthetic dyes dealt with will exceed 1,320, as against the 1,000 dealt with by Schultz. Most of these dyes have a number of commercial names—many of them thirty or

more—and in all cases these names and the respective makers are given. The products of over a hundred colour-making firms are included, and the matter covers 700 large quarto pages of closely-printed and condensed matter.

A dye user who requires a particular dye can thus find a complete list of the manufacturers who make it, the scientific name of the product, its components and formula, details of its preparation, its discoverer, exhaustive references to the literature on the subject, its properties, uses, and modes of application.

Many Industries Covered.

In addition to the Synthetic dyestuffs, the Colour Index will include the principal colouring matters and the pigments. Dyes are used not only in the great textile industries, but in a large number of other industries, such as the paint and varnish, paper making, soap and oil, in photography, medicine, foodstuffs, and so on. Details are given of dyes specially used in photography, which have not been included in any previous work. There are some particularly valuable references to the suitability of dyes for calico printing, especially with regard to dischargeability.

This great work will supersede all former reference books, and there is no doubt that it will be of great practical as well as scientific utility. It will guide the dye-user safely through the maze of modern dyestuff names, and enable him to make the fullest use of the enormous developments in the dye-making industry in recent years.

THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

The Lord President of the Council has accepted with much regret the resignation of Sir George Beilby, LL.D., F.R.S., after nearly seven years' voluntary service as Director of Fuel Research and Chairman of the Fuel Research Board under the Department of Scientific and Industrial Research. The Board was established in 1917 to investigate the nature, preparation and utilisation of fuel of all kinds.

The Lord President has appointed Mr. C. H. Lander, D.Sc., M.I.Mech.E., A.M.-Inst.C.E., to be Director of Fuel Research, and Sir Richard Threlfall, K.B.E., F.R.S., a present member of the Board, to be Chairman. The Hon. Sir Charles Parsons, K.C.B., F.R.S., will continue his membership of the Board for a further period. Sir George Beilby retains his membership of the Advisory Council of the Department, and has consented to act as Honorary Adviser to the Board.

The following gentlemen have accepted appointment as additional members of the Board:—

Mr. R. A. Burrows, Sir John Cadman, K.C.M.G., D.Sc., Dr. Charles Carpenter, C.B.E., D.Sc., Mr. Samuel Tagg, Prof. Sir James Walker, D.Sc., LL.D., F.R.S., Prof. R. V. Wheeler, D.Sc.

DYESTUFFS (IMPORT REGULATION) ACT.

Applications for Licences in May.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during May, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 497, of which 409 were from merchants and dealers. To these should be added the 17 cases outstanding on May 1, making a total for the month of 514. These were dealt with as follows:—

Granted—304 (of which 293 were dealt with within seven days of receipt).

Referred to British makers of similar products—136 (of which 130 were dealt with within seven days of receipt).

Referred to Reparation Supplies available—53 (all dealt with within two days of receipt).

Outstanding on May 31—21.

Of the total number, 514, of applications received, 458, or 89 per cent., were dealt with within four days of receipt.

Board of Trade.
June 12, 1923.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Thursday, June 14.

Papers read:—

C. Chree, F.R.S. *Magnetic Phenomena in the Region of the South Magnetic Pole.* Magnetographs were in simultaneous

operation from April to October, 1912, at the base stations of the British and Australasian Antarctic expeditions. These stations were situated on opposite sides of the south magnetic pole. A comparison is made of the regular diurnal inequalities and the amplitudes of the absolute daily ranges of the magnetic elements at the two stations. The data are employed to illustrate the remarkable sensitiveness of the regular diurnal variations in high latitudes to the presence of magnetic disturbance. The results are also applied to the question of a suitable criterion for the daily activity of magnetic disturbance.

O. R. HOWELL. *The Catalytic Decomposition of Sodium Hypochlorite by Cobalt Peroxide.*

1. The rate of decomposition of sodium hypochlorite solution by cobalt peroxide is directly proportional to the amount of peroxide present.

2. The rate is accelerated by sodium salts and (in the case of sodium chloride) is directly proportional to the square root of the concentration of sodium ions present. This is explained by assuming the mechanism of the reaction to consist in the linkage of hypochlorite ions to the positive oxygen and sodium ions to the negative oxygen of the peroxide, with subsequent immediate decomposition of the quadrivalent oxygen compound. In the presence of a fixed amount of hypochlorite the rate is then proportional to the degree of adsorption of the sodium ions.

3. The rate is retarded by alkali and the retardation is proportional to the adsorption of hydroxyl ions. This is explained by the fact that hydroxyl ions are attracted by the positive oxygen of the peroxide yielding an inactive compound to the exclusion of hypochlorite ions.

4. The rate of the reaction has been measured between 25° and 50°. The average temperature coefficient over this range is 2.37 and the Arrhenius activation coefficient $E = 16{,}574$.

5. The catalyst is not affected by any of the common catalytic poisons.

N. M. HOSALI. *On Seismic Waves in a Visco-Elastic Earth.* Communicated by Prof. L. N. G. Filon, F.R.S.

The effects of viscosity on the propagation of seismic waves are considered, the medium being assumed to obey certain stress-strain relations given recently by Prof. L. N. G. Filon.

It is found that the waves are subject to damping and dispersion dependent on the period. For each type of wave—dilatational, distortional or surface—there exists a minimum period below which a wave cannot be transmitted, and for any period above the minimum two distinct waves can be propagated, one heavily damped and slow travelling, and one lightly damped and quick travelling.

The observed reduction in the amplitude of oscillations in the main shock, as the epicentral distance increases, indicates that if the material in the outer layers of the earth obeyed the theory here developed, it would have a viscosity of order 10^8 or 10^9 c.g.s. units. Such a viscosity would have no appreciable effect on the velocity of propagation of earthquake waves.

The vibrations of an incompressible, visco-elastic sphere are briefly discussed, and it is shown that viscosity produces damping and lengthening of period. The oscillatory modes of any species are finite in number and can be divided into two groups, one more heavily damped than the other.

Papers read in title only:—

J. W. LANDON and H. QUINNEY. *Experiments with the Hopkinson Pressure Bar.* Communicated by Sir A. Ewing, F.R.S.

The paper deals with some experiments carried out since the late Prof. Bertram Hopkinson's paper (*Phil. Trans.*, 1914).

It is found that when the firing end of the bar is coned down to a smaller diameter and the time-piece is sufficiently long, the bar itself is left with a negative momentum. A theoretical investigation of the propagation of a pressure wave along a cone of small angle shows that as the wave proceeds along the cone a tail of tensile stress is formed. Experimental results agree fairly closely with theoretical.

The experimental observations show that with a bar of uniform diameter the pressure wave produced by detonation of gun-cotton is considerably distorted as it is propagated, but that the rate of distortion decreases as the wave travels along the bar.

A graph is deduced from experiments showing variation of pressure over cross-section of the bar when a gun-cotton primer is detonated $\frac{3}{4}$ inch away from the end,

Pressure falls away rapidly as distance from axis of the bar increases.

One of the objects of further experiment was to determine with greater accuracy the maximum pressure produced in the detonation of gun-cotton. It was hoped that the overstrain might be reduced by special heat treatment of the bars, and that the pressure transmitted would be more nearly the true pressure at the firing end. There is no evidence from the experiments that any substantial improvement has been effected by heat treatment except in so far as the life of the bars has been increased.

The highest maximum pressures recorded were 117 tons per square inch for a 1-ounce gun-cotton primer in contact with the end of the bar, and 82 tons per square inch with the primer ½ inch away from the end. These results were obtained with a short bar of ¾-inch diameter.

With concrete bars the phenomena exhibited are the same in general as with steel bars, except that the front of the wave appears to be entirely obliterated, and only the part in which pressure is less than the crushing stress of the concrete is propagated along the bar.

S. F. Grace. *Free Motion of a Sphere in a Rotating Liquid at Right Angles to the Axis of Rotation.* Communicated by G. I. Taylor, F.R.S.

The paper forms a companion to a previous one dealing with the motion of a sphere parallel to the axis of rotation. The density of the sphere is equal to that of the liquid, and the motion a small disturbance from one of uniform rotation like a rigid body; the system is free from bodily forces and initially disturbed by a motion suddenly communicated to the sphere. The subsequent motion of the centre of the sphere is wholly in a plane perpendicular to the axis of rotation (the equatorial plane), and the disturbed motion of the liquid is symmetrical with respect to this plane. The path of the centre of the sphere is a spiral with a definite pole. The sphere winds round the pole in a direction opposite to that of the rotation of the liquid while continually approaching it, the motion being such that the time of a complete turn tends to become constant and equal to one-half the time of a revolution of the undisturbed liquid. The motion of the liquid in the equatorial plane tends rapidly to zero away from the sphere. At axis of the sphere the motion is parallel to the equatorial plane and is a maximum at the sphere. At any point in the sphere the velocity of the liquid relative to the sphere is the component in the tangent plane of a vector of constant magnitude which uniformly describes a right circular cone. Parts of the solution are not applicable for large values of time.

B. F. J. Schonland. *The Passage of Cathode Rays through Matter.* Communicated by Prof. S. Ernest Rutherford, F.R.S.

1. The absorption of cathode rays of velocity 6.10^9 to $1 \cdot 2.10^{10}$ cms./sec. in various metals has been studied with an arrangement designed to eliminate interferencee from secondary rays and to measure both the fraction of the beam passed through and that actually absorbed in the foil.

2. The latter fraction varies with thickness and velocity in the same manner for all elements; the nature of the variation of the former depends upon the absorbing material.

3. The conception of a range for these particles is established by two independent methods of measurement.

4. The results are explained by applying the theory of absorption due to Bohr, with which they are in quantitative agreement.

THE CHEMICAL SOCIETY.

Ordinary Scientific Meeting, Thursday, June 21.

The following papers were read:—

The Constitution of the Higher Oxide of Nickel. O. R. Howell.

The Relationship of the Tautomeric Hydrogen Theory to the Theory of Induced Alternate Polarities. F. Allsop and J. Kenner.

Electron Valency Theories and Stereochemistry. S. Sugden.

The Relative Influences of Water Vapour and Hydrogen upon the Combustion of Carbon Monoxide—Air Mixtures at High Temperatures. W. A. Bone, D. M. Newitt, and D. T. A. Townend.

Metallic Hydroxy-Acid Complexes. Part I.—Cuprilactates. I. W. Wark.

Metallic Hydroxy-Acid Complexes. Part II.—Cuprimalates, their Formation, Properties, and Composition. I. W. Wark.

Cholesterol and its Rôle in the Organism

THE ROYAL INSTITUTION.

"Atomic Projectiles and Their Properties."

On Saturday, June 16, Sir Ernest Rutherford delivered his postponed lecture on the above subject.

He gave some of the results he and Dr. Chadwick have obtained in the Cavendish Laboratory by utilising α particles, spontaneously fired from radio-active substances at incredible speeds, in their attempts to disintegrate the atoms of various elements.

Remarkable results have been obtained with certain elements, including boron, nitrogen, sodium, aluminium, fluorine, and phosphorus. Constituents of the atoms of these elements have been expelled by α particles, and, at least temporarily, something like the transmutation of the elements has been accomplished.

With special apparatus it has been demonstrated that the particles thus expelled are in all cases hydrogen atoms, sometimes in that form and at others in the form of helium nuclei, which consist of four hydrogen nuclei bound together.

It seems almost certain, therefore, that the ultimate "bricks" from which all substance are built up are hydrogen nuclei, the manner in which they are combined in any particular atom determining the nature of the element of which it is a part.

The fact that, when an alpha particle entered the atomic nucleus of substances like aluminium, hydrogen nuclei were frequently projected backwards as well as forwards was a strong corroboration of the theory that the central nucleus of an atom was surrounded by electrons moving rapidly round the nucleus.

The speed and direction of motion of any of these "satellite" electrons, when struck by an intruding α particle, would depend on its position in its orbit when hit, and Sir Ernest showed by a diagram how, under certain conditions, an electron would be projected in such a way as to sweep close around the nucleus and return on the other side in the same direction as it approached the central region.

Experimental work in this field is very difficult and expensive, but the results are so fundamental in their nature as to promise the solution of many of the problems of physics and chemistry which a few years ago seemed incapable of solution. Among these are the actual transmutation of the elements—and the possibility of harnessing the stupendous energy at present locked up in the complex structure of the atom.

ROYAL AGRICULTURAL SOCIETY.

Proceedings at Monthly Council,

Wednesday, June 6, Lieut.-Col. E. W. Stanyforth (President) in the Chair.

The Reports of Committees included:—

Chemical.

Mr. Luddington (Chairman) reported that a list of the samples analysed by the Consulting Chemist during the past month had been submitted.

A letter had been received from the Ministry of Agriculture stating that the personnel of the proposed Departmental Committee on the Fertilisers and Feeding Stuffs Act was under consideration, and that an announcement on the subject would be made shortly. A further letter had been received from the Ministry, asking for copies of any report embodying any conclusions that had been arrived at by the Conference of representatives of the Society with other bodies. It had been left to the Chairman and Dr. Voelcker to draw up a report for submission to the Ministry.

Dr. Voelcker had reported to the Committee regarding various matters arising out of his correspondence.

Botanical and Zoological.

Mr. Plumptre, in the unavoidable absence of Mr. Coltman-Rogers (Chairman), presented the following Reports that had been made to the Committee by the Botanist (Professor R. H. Biffen, F.R.S.), and the Zoologist (Mr. Cecil Warburton, M.A.).

Research.

Manuring of Pasture Land.—An interim report was received on the experiments initiated in Leicestershire on the effect of basic slag and other fertilisers on pasture land as measured by the increase in weight of cattle and sheep. The ground has been prepared and fenced into plots and water supplied. The stock was placed on the plots on May 31, and the first year's control experiment, during which no fertilisers are to be used, has thus been begun.

Ensilage.—Experiments have been arranged under the superintendence of Mr. A. Amos, of Cambridge, on the value of silage as food for dairy cows, and its effect on the yield and quantity of the milk. Not every farmer has, or can afford to build, a tower silo, and Mr. Amos is going to preserve the silage in clamps—pits in the ground, in which the fodder is compressed and covered with earth.

Another related research is to be carried out by Mr. Oldershaw in East Suffolk. Tower ensilage will be made this summer and fed to dairy cows next winter to test how far the protein contents of silage can be used to save expensive cakes, the deficiency in carbohydrates being balanced by other foods, such as oats or barley or molasses.

It was resolved that £100 be devoted to these experiments.

MINERALOGICAL SOCIETY.

TUESDAY, JUNE 19.

Papers received:—

DR. L. J. SPENCER (with chemical analyses by E. D. Mountain): *New Lead-Copper Minerals from the Mendip Hills (Somerset).*

DR. W. F. P. MCLINTOCK: *On a Petalite-bearing Rock from Devonshire.*

MESSRS. A. BRAMMALL and H. F. HARWOOD: *Dartmoor Granite: Monazite and other accessory Minerals; tourmalinisation.*

SEITARO TSUBOI: *Optical Dispersion of three Intermediate Plagioclases.*

SEITARO TSUBOI: *A Method of Determining Plagioclases in Fine Grains.*

C. S. GARNETT: *The toadstone clays of Derbyshire.*

DR. G. T. PRIOR: *On the Meteoric Stone which fell at Ashdon, Essex, on March 9, 1923.*

DR. G. T. PRIOR: *The Sinai Meteorite.*

LIVINGSTONE COLLEGE COMMEMORATION DAY.

A very successful commemoration day was held at Livingstone College on June 13. The chair was taken by Sir Leonard Rogers, C.I.E., F.R.S.

Short statements were made by the Principal, Dr. Tom Jays, and the Treasurer, Mr. R. L. Barclay, as to the work of the past year, and the financial and general position of the College.

SOCIETY OF GLASS TECHNOLOGY.

A meeting was held at the Leeds Institute, on Wednesday, June 20. The following papers were received and discussed:—

Specifications in the Glass Industry, by PROF. W. E. S. TURNER, D.Sc.

Notes on the Design of Pot Arches, by TH. TEISEN, B.Sc.

Notes on the Ashley Bottle Machine, by S. ENGLISH, M.Sc.

The Effect of Titania on the Properties of Glass, by A. R. SHEEN and PROF. W. E. S. TURNER.

INDUSTRIAL PHYSICAL RESEARCH IN AMERICA.

In his recent Presidential Address to the Institute of Physics, Sir J. J. Thomson gave some account of the work he had seen during his recent visit to America in the research departments of some of the great manufacturing firms. These laboratories were established in the face of considerable opposition, but now the universal opinion appears to be that the research department is one of the most profitable in manufacturing concerns, and however great the necessity for economy its cost would be the last to be reduced.

The scale of these laboratories was far greater than anything we have in this country, and much of the work carried out is not merely what might be called development work, but is fundamental scientific work, worthy of a university laboratory.

On the other hand the American universities do not seem designed to produce a large number of men qualified to take up advanced research work. For example, few of the science students have the necessary equipment in mathematics and the stern training which a good Honours man in a great English university has to go through appears to be unknown. The system is doubtless good for the average man, but a successful research institute requires something more than the average man; it needs men with high scientific knowledge. In this regard this country has a distinct advantage we shall sorely need if we are to hold our own in competition.

NOTICES OF BOOKS.

The Manufacture of Acids and Alkalis, by GEORGE LUNGE, completely revised and rewritten under the Editorship of ALEXANDER CHARLES CUMMING, D.Sc., F.I.C. Volume I.—*Raw Materials for the Manufacture of Sulphuric Acid and Sulphur Dioxide*, by WILFRID WYLD. Pp.

XIII. + 558. London: Gurney & Jackson, 33, Paternoster Row, E.C. 1923. Price 36s. net.

Prof. Lunge's *Sulphuric Acid and Alkali* first appeared in 1879. The last edition, for which he was still responsible, was published in 1913. In the meantime the progress in chemical industry has necessitated various revisions and much extension. Much of the earlier editions is naturally now obsolete, and even the security of old-established Lead Chamber process is seriously threatened by the newer Catalytic processes.

The present edition, dealing with the heavy chemical industry, has been based upon a very thorough revision of the older work. Much new matter has been introduced, more particularly concerning the by-products, which have lately assumed increasing importance. Illustrations and descriptions of new plant have also been introduced.

Perhaps the most useful parts of this volume are those dealing with the properties and technical analyses of the oxides of sulphur, and the detailed account of the various types of natural and recovered sulphur used in the heavy chemical industry.

Volume V.—*The Manufacture of Hydrochloric Acid and Salt Cake*, by ALEXANDER CHARLES CUMMING, D.Sc., F.I.C. Pp. XV. + 423. Price 31s. 6d. net.

In this volume, the numerous industrial methods for making salt cake and also hydrochloric acid are given in adequate detail.

Early chapters describe the raw materials. The chapter on the manufacture of salt cake and hydrochloric acid is naturally the longest, but there is much of importance to industrialists in the accounts of various processes for making sodium sulphate as the main product from salt. This is also true of the chapter dealing with this substance as a by-product.

The Hargreaves process, which has been the subject of so many patents, is still described in good detail, although it is recognised that such old processes are rapidly being superseded.

The later chapters on the winning of hydrochloric acid are largely taken up with the mechanical and absorbing arrangements of the plant.

The constantly increasing over-production of electrolytic chlorine has led to this element being combined with hydrogen, either directly or by interaction with steam. The account of these methods should prove very instructive to those for whom these treatises have been compiled. Doubtless when a new edition of this highly important work is issued, this section will need to be enlarged with more detail.

The other volumes of this revised edition will be awaited with interest by industrial and technical chemists.

BOOKS RECEIVED.

The Constitution of Matter, by MAX BORN, translated by E. W. BLAIR, D.I.C., B.Sc., and T. S. WHEELER, B.Sc., A.R.C.Sc.I. Pp. VII. + 80. 1923. Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C.2. 6s. net.

Alcoholic Fermentation, by ARTHUR HARDEN, PH.D., D.Sc., F.R.S. Pp. 194. Third Edition. 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 6s. 6d. net.

Practical Bacteriology for Chemical Students, by DAVID ELLIS, PH.D., D.Sc., F.R.S.E. Pp. VIII. + 136. 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 4s. 6d. net.

Chemistry, Inorganic and Organic, with Experiments, by CHARLES LOUDON BLOXAM. Pp. IX. + 832. Eleventh Edition. 1923. Messrs. J. & A. Churchill, 7, Great Marlborough Street, W.1. 36s. net.

PUBLICATIONS RECEIVED.

In the Bulletin No. 211, published by the U.S. Dept. of the Interior (Bureau of Mines), entitled *The Chloride Volatilisation Process of Ore Treatment*, by THOMAS VARLEY, E. P. BARRETT, C. C. STEVENSON, and R. H. BRADFORD, it is pointed out that the art of treating ores by the chloride volatilisation process is still in the experimental stage. The process has not yet been sufficiently developed along metallurgical lines to warrant a definite statement as to the exact place it will occupy in the industry. The basic theory of the process has attracted the attention of prominent metallurgists, and considerable research and experimental work has been accomplished.

Much of the experimental work done has not been published; but if the accumulated results were made known, they would greatly aid the further development of the process. The bulletin aims to bring the salient features of the process to the attention of metallurgists for the purpose of furnishing information to and receiving comments from interested parties with the ultimate hope that the process will be a commercial success.

If commercially utilised, the process will fill a long-felt want in metallurgy, especially in the treatment of oxidised and semi-oxidised or "carbonate" ores of copper, lead, and silver. Such ores are difficult to treat by gravity concentration or by flotation; in the former their tendency to slime upon crushing and their being of lower specific gravity than the sulphide minerals cause serious losses; in the latter much has been done in sulphidising oxidised ores and subsequently recovering the artificial sulphides by flotation. Difficulties in proper sulphidising and the low recoveries obtained have not balanced the cost of the treatment in many plants, and in very few has it proved successful.

Evidently there is a big void to fill in the treatment of these ores. No radical changes in present methods are forecast, but it is obvious that chloride volatilisation can have a distinct place as a method of treatment for ores that are not readily amenable to present methods. In many plants it might replace concentration methods, especially where part of the mineral content in the ores exists in forms other than sulphides.

In addition to the minerals named above, gold in ores has been readily volatilised. Zinc does not form a volatile chloride, if an oxidising condition is maintained in the roasting operations. Some excellent results have been obtained with carbonate-zinc concentrates containing silver and lead. Practically all the silver and lead were volatilised, but very little of the zinc. Experiments have proved that the process is probably one of the best for making a clean-cut separation of lead and zinc.

Not much work has been done on sulphide ores, because the need is pressing for a volatilising method for treating oxidised and carbonate ores. Experiments on sulphides have been, however, encouraging. When the sulphur content is above 5 per cent. a preliminary roast is usually necessary before chloride roasting and volatilisation.

The effect of sulphur is discussed by Croasdale in his chapter on the history of the process. He and other investigators declare that sulphur is a consumer of salt, and when it is present in an ore in excessive amounts a proportionately larger amount of salt is required to effect the chloridisation and volatilisation of the metals present.

The process would doubtless be favourable for use in regions not well supplied with water. All the apparatus required for the construction of a plant are practically standard mechanical devices and machinery. The most important raw materials in the operation of a plant are the fuel and the salt or other haloid. In mining districts remote from railroads these materials, of course, would be the largest factor in the cost of running a plant. Nevertheless, the cost would often be more than offset by the freight charges on the concentrates and other supplies necessary for a plant using almost any other kind of process. These conditions will be discussed in some detail in describing the operations of plants that have been built.

The experiments described cover part of the investigations carried on by the U.S. Bureau of Mines on ores from all parts of the United States. Large quantities of different types of ores not amenable to any other process were available, and the method developed gives promise of great commercial importance.

New Patents.

This list is specially compiled for The Chemical News, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all *information relating to Patents*, Trade Marks, and Designs can be obtained gratuitously.

Abstract Published this Week.

195849—Cellulose acetate solutions and compositions; celluloid; films; varnishes.—British Cellulose & Chemical Manufacturing Co., Ltd., 8, Waterloo Place, London; Bader, W., and Dickie, W. A., British Cellulose & Chemical Manufacturing Co. Works, Spondon, near Derby.

Celluloid-like products, plastic masses, films, *varnishes, solutions and other preparations and* compositions having a basis of cellulose acetate, are prepared with the employment of tri-chlor tertiary butyl alcohol as solvent *or plastifier*; celluloid prepared in this manner is tough, elastic and non-inflammable. According to the use, volatile or other solvents, diluents, plastifiers, filling materials, colouring matters, &c., may be added. In examples, celluloids are prepared with the aid of the tri-chlor tertiary butyl alcohol with or without the addition of triphenyl phos*phate or castor oil; films*, using a solution to which acetone has been added; and a varnish, with the addition of acetone or methyl acetate.

Messrs. *Rayner & Co. will obtain* printed copies of the published specifications only, and forward

THE CHEMICAL NEWS,

VOL. CXXVI. No. 3298.

NOTE UPON THE PROPERTIES OF MUSCARINE.

By John Missenden, B.Sc.

Muscarine, which is a content product of a number of poisonous fungi (notably the *Amanita muscaria*), has the formula $C_5H_{15}O_3N$, *but its constitution is unknown*. Formerly, it was believed to be a choline oxy-substitution product. Schmiedeberg and Harnack,[1] in their reaction with choline and nitric acid, gave the base obtained (which they believed to be muscarine) as $OHN.(CH_3)_3.CH_2CH(OH)_2$. The arguments of both Berlinerblau[2] and Boehm[3], however, very conclusively show that this base possesses neither the properties nor constitution of muscarine, the conclusions being the outcome of careful comparison with the natural product. At the same time, until more is known of the subject, *the synthetic product may be accepted as a* choline ester of the constitution $OHN.(CH_3)_3CH_2.CH_2ONO$. Natural muscarine, we believe, possesses a totally different constitution; *i.e.*, $NO.CH_2.(CH_3)_2.CH_2.CH_2.NO.OH$, although there is some doubt as to the exact placement of the initial nitrosyl group.

Natural muscarine is certainly not a choline ester, inasmuch that its solutions are not decomposed by boiling in acid and alkaline solutions. Discussions upon the matter were reported by Weinhagen.[4] It is worth noting that the physiological action of muscarine resembles that of acetyl-choline.

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[1] *Arch. ex. Path. Pharm.*, 1877, VI., 101.

[2] *Ber. Deut.*, 1884, XVII., 1141.

[3] *Arch. ex. Path. Pharm.*, 1885, XIX., 187.

[4] *Journ. Amer. Chem. Soc.*, 1920, XLII., 1670.

DISTRIBUTION OF INSECTICIDE BY AEROPLANE.

Mr. R. O. Wahl, Lecturer in Entomology in South Africa, who recently returned to that country from America, reports that when visiting the State Experiment Station at Wooster, Ohio, during last year, his attention was drawn to an experiment carried out by that Experiment Station and the City of Cleveland, in co-operation with the United States Air Service, in combating an outbreak of the catalpa sphinx (*Ceratomia catalpae, Bvd.*) *in a catalpa grove by* distributing the insecticide from an aeroplane. Through the courtesy of the officers conducting the experiment it was possible for Mr. Wahl to take an active part in the work, seeing the dusting from the ground and the air, and in assisting in checking the results immediately after the dusting after a lapse of 24 hours and again a week later. The section of the wood sprayed was a dense grove containing trees of different kinds, elm, spruce, maple, etc., and varying in size from 60 ft. down. There was considerable thick undergrowth as well as much bracken and large plantings of rhododendrons. The penetration of the dust was remarkable and the killing very successful. Unfortunately, a heavy thunderstorm and torrential downpour occurred a few hours after the competion of the dusting and robbed it of much of its value. A portion was redusted the following day, resulting in a practically total killing of the caterpillars.

Much more experimental work is necessary, but a new field of investigation in this direction is opened to the entomologist and other scientists and one that appears to have great possibilities.

MACHINERY FOR PHARMACEUTICAL PREPARATIONS REQUIRED IN AUSTRALIA.

Mr. S. W. B. McGregor, ...M. Senior Trade Commissioner in Australia, reports that a Melbourne firm of manufacturing chemists specialising in the production of *galenicals and other pharmaceutical* preparations, are desirous of receiving particulars from British manufacturers of any machinery, appliance, apparatus, etc., used in the manufacture of such products *in a wholesale* way, such as percolators

(mechanical and otherwise), evaporators, boiling pans, filters (*not* water filters). They are particularly interested in any plant that would be of service in the manufacture of extract of glycyrrhizæ and extract of cascara on a large scale.

The firm are understood to be of good repute and standing.

British firms interested in this enquiry can obtain the name and address of the enquirers upon application to the Department of Overseas Trade (Room 52), 35, Old Queen Street, S.W.1.

GERMANY'S TRADE AND INDUSTRY IN MAY.

Mr. F. Thelwall, Commercial Secretary at Berlin, has forwarded to the Department of Overseas Trade information on German trade and industry during May.

In spite of the unfavourable general situation, there was a not inconsiderable improvement in business in many branches of industry. The special feature in trade was the rise of the dollar, which again led to an increased desire to purchase on the part of inland customers, while foreign sales improved in consequence of the greater span between prices and of the easier export conditions. German industry also benefited by the altered conditions, although its outlook for the future continues melancholy. New difficulties arose in procuring British coal, the import of which, owing to the depreciation of the mark, had, of course, to be restricted. The coal stocks had, therefore, to be broken into to a larger extent. In occupied territory the strike did not greatly affect the industrial situation. In unoccupied Germany also, as a result of the rise in prices amounting to 33.8 per cent. as compared with April, new wage demands were made.

Mining.

The coal position of industry in occupied territory continued to depend on the measures of the occupying Powers. Many cokeries ceased work. Most pits only produced sufficient coal to meet the needs of their own foundries. In many cases transport between the foundries and the pits has been interrupted by the occupying Powers. The price of coal was raised to 143,510 marks per ton.

In the potash industry, inland trade had at first still to suffer from considerable difficulties. The freight reductions for the summer introduced by the German Potash Syndicate led, however, to a substantial improvement of sales in the second half of May. By the summer reductions, the potash industry gave agriculture, as in the previous year, the opportunity of covering during the summer months a considerable portion of its autumn requirements at reduced freights. Foreign business also became lively on the renewed depreciation of the mark and exportation took place, particularly to America. Alsatian competition made itself increasingly felt in foreign trade. Coal deliveries left nothing to be desired.

Electro-Technical Industry.

Measuring instruments found a good market, and business activity in the high-pressure current industry increased.

Chemical Industry.

The chemical preparations industry still suffered at the beginning of the month under the prevailing disinclination to buy. On the rise of the dollar, business revived on a continually increasing scale. Many orders from abroad were also received, so that at present the degree of employment is comparatively favourable. Practically no benefit accrued to the works from the new export facilities, as the reduction of the export duty did not go nearly far enough. In the sheet glass industry, exports at first declined further compared with the preceding month; then, as a result of the fall of the mark, a considerable demand from abroad set in. Exportation to Italy, Reval, and also to America and Africa took place from accumulated stocks.

In the hollow glass industry the supply of raw materials and of coal was adequate; soda deliveries improved. Work for stock had in part to be done. In the case of some special articles a slight improvement of sale conditions was reported.

Indiarubber.

Conditions in the indiarubber industry much improved as a result of the further depreciation of the mark. Fearing a further rise of foreign values, consumers sought to cover their requirements anew and to effect substantial purchases which presumably did not correspond with the actual consumption.

GENERAL NOTES.

DIE CASTING RESEARCH.

AIDS TO MASS PRODUCTION.

The British Non-Ferrous Metals Research Association has undertaken an extensive sèries of investigations on Die Casting Alloys which will spread over at least three years, and entail an expenditure exceeding £10,000. Full particulars of the scheme can be obtained from the Association's headquarters, 71, Temple Row, Birmingham.

The development and support of die casting in this country as a means of rapid production, is recognised as of great national importance both for ordinary commercial production, in the most diverse industries, as also for munitions and equipment of the fighting services.

The Department of Scientific and Industrial Research, after holding conferences of those interested in die castings, has promised most substantial financial support to the research. The Research Associations of the British Motor and Allied Industries, of the Scientific Instruments, and of the Electrical and Allied Industries have also afforded their support, and are represented on the Committee controlling the investigations. It remains for the industry—makers and users—to provide their quota of the fund required, as without this it will be impossible to fully develop the work, the results of which will be primarily available to those who support the research.

Since die castings serve chiefly as components of plant and machinery, it is not always recognised how important they are, but anyone enquiring into the subject will come across very varied uses in the automobile industry, and such applications as brush gear of electrical machinery, gas meter parts, vacuum cleaner fittings, etc., etc.

Sooner or later, almost every branch of industry in which metal parts of any complicated shape are required, turns to die castings as the ideal for economical production. The sphere of application will extend considerably if the research work contemplated succeeds in improving the quality and assuring the reliability of the alloys used.

Various types of alloys are used in die casting, and recognising the wide field, the proposed research has been divided into three sections: 1, Brass and Bronze Alloys; 2, Aluminium Alloys; 3, Low Melting Point Alloys (Zinc, Tin, Lead, etc.). These three branches, with suitable arrangements for co-operation, will be dealt with in separate institutions, under the supervision of recognised leaders of metallurgical research.

Every care is being taken in the constitution of the Committee which controls the work, to ensure that both the manufacturers and the users are represented.

Work of this nature demands the close interest of the industry, and it is hoped that no difficulty will be experienced in obtaining the small subscriptions required to assure the substantial Government support, which is only available in a measure dependent on the backing of the scheme by the industry.

PHYSICAL AND CHEMICAL SURVEY OF THE NATIONAL COAL RESOURCES.

One of the main functions of the Fuel Research Board is a survey and classification of the coal seams in the various mining districts by means of chemical and physical tests in the laboratory, supplemented where desirable by large scale tests at H.M. Fuel Research Station, East Greenwich, or elsewhere. The Board consider that the best way to carry out this work is by means of local committees, the personnel of which would include colliery owners, managers, representatives of the Fuel Research Board, and of the Geological Survey of Great Britain, as well as of outside scientific interests. Each committee would be charged with the duty of superintending the work of the survey in a coal mining area; and in this way the survey would become, from the commencement, of practical value, since local knowledge and experience would be made available, and the selection of seams would be decided by those most likely to estimate correctly the relative importance of the problems to be solved. The seams selected would undergo physical and chemical examination by the local experts, after which a final selection would be made of those likely to justify experiments on a practical scale to test their suitability for particular uses or methods of treatment.

The first of these committees has now

been actively at work in the Lancashire and Cheshire area for nearly eighteen months, and the Board have recently appointed a committee to deal with the survey in the South Yorkshire area. The South Yorkshire Coal Trade Association and the Midland Institute of Mining, Civil and Mechanical Engineers are co-operating in the work. The composition of the committee is as follows:—

Mr. J. Brass, Mr. Robert Clive (hon. secretary) and Mr. H. Danby—representing the South Yorkshire Coal Trade Association.

Lieut.-Col. H. Rhodes, M.Inst.C.E., M.I.Min.E., F.S.I.—representing the Midland Institute of Mining, Civil and Mechanical Engineers.

Prof. R. V. Wheeler, D.Sc.

Mr. C. H. Lander, D.Sc., M.I.Mech.E., A.M.Inst.C.E., Director of Fuel Research (Chairman *pro tem*)—representing the Fuel Research Board.

Mr. Walcot Gibson, D.Sc.—representing the Geological Survey of Great Britain.

The Federation of British Industries has issued an interim report on inter-Imperial trade.

The report does not cover every aspect of inter-Imperial trade, and the Federation propose, at a later date, to address one or more further reports to the Government, dealing with the questions which are not dealt with in the present report.

In the Federation's opinion, the fullest possible development of inter-Imperial trade is essential in the interests of the Empire as a whole, both for economic, political and social reasons. The problem should be approached not merely from the point of view of the advantages likely to accrue to Great Britain, but from the point of view of mutual advantage to all parts of the Empire.

FINE GLASS IN THE MANSARD GALLERY.

An extremely interesting exhibition of fine glass has recently been opened at the Mansard Gallery, 196, Tottenham Court Road, London, W.1.

Carefully selected from a number of countries, the play of light on the varied colours and textures gives an atmosphere of fairyland. Light shapes in clouded topaz and smoke grey come from Sweden. Sea green and pale amethyst fantasies of the Venetians contrast with the deep richness of our own Old Bristol blue and puce. Limpid crystal from the old Whitefriars works, and the sturdy cut table glass from Edinburgh reflect in their facets the shimmer of Czecho-Slovakia's amber lustre and the orange glow of bowls from France. The consummate artists of Murano have sent a few pieces flecked with gold, while a table set with iridescent glass from Holland holds all the glories of a bubble in the sun. The revival of industries in Palestine is shown by some characteristic peacock blue glass from Hebron.

Alongside these contributions from far lands are tables laid with simple, well-shaped wine-glasses and tumblers in plain crystal; practical and graceful vases for flowers, and larger ones for tall spikes of delphiniums or spreading boughs. A collector's piece is the tall engraved goblet made to commemorate the Armistice, bearing the appropriate inscription: *Dominus loquitur—arma silent,* and dated the eleventh hour of the eleventh day of the eleventh month, 1918.

The revival of the prismatic lustre glass for electric lighting is particularly happy. A series of these lustre light pendants and wall brackets will be of particular interest to architects.

The exhibition, which has been organised by Messrs. Heal and Sons, of Tottenham Court Road, is being held during the present and the next month. Admission is free. —*The Board of Trade Journal.*

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, JUNE 28.

Paper read:—

PROF. V. H. BLACKMAN, F.R.S., A. T. LEGG, and F. G. GREGORY. *The Effect of a Direct Electric Current of very Low Intensity on the Rate of Growth of the Coleoptile of Barley.*

Papers read in title only:—

MISS R. M. TUPPER-CAREY and PROF. J.

H. PRIESTLEY. *The Composition of the Cell Wall at the Apical Meristem of Stem and Root.* Communicated by Dr. F. F. Blackman, F.R.S.

L. J. HARRIS. *The Titration of Amino- and Carboxyl Groups in Amino-Acids, Polypeptides, etc.* Communicated by Prof. F. G. Hopkins, F.R.S.

DR. M. S. PEMBREY, F.R.S., N. W. MACKEITH, W. R. SPURRELL, E. C. WARNER, and H. J. WESTLAKE. *Observations on the Adjustment of the Human Body to Muscular Work.*

F. A. E. CREW. *Studies in Intersexuality. II.—Sex-reversal in the Fowl.* Communicated by Prof. R. C. Punnett, F.R.S.

PROF. W. FINKLER. *Analytical Studies on the Factors causing the Sexual Display in the Mountain Newt (Triton alpestres).* Communicated by Prof. E. W. MacBride, F.R.S.

G. A. SCHOTT, F.R.S. *On the Scattering of X and γ Rays by Rings of Electrons—The Effect of Damping of the Incident Radiation.*

MAJOR P. A. MACMAHON, F.R.S. *On a Class of Transcendents of which the Bessel Functions are a Particular Case.*

L. C. MARTIN, D.Sc. *The Photometric Matching Field.* Communicated by Prof. H. L. Callendar, F.R.S.

G. P. THOMSON. *Test of a Theory of Radiation.* Communicated by Sir Joseph Thomson, F.R.S.

A. LL. HUGHES, D.Sc., and P. LOWE. *Intensities in the Helium Spectrum.* Communicated by Prof. H. A. Wilson, F.R.S.

A. A. DEE. *The Effect of Quenching from above the Carbide Transition Temperature upon the Magnetism of Steel.* Communicated by Prof. S. W. J. Smith.

T. S. P. STRANGEWAYS and H. E. H. OAKLEY. *The Immediate Changes observed in Tissue Cells after exposure to Soft X-Rays while growing "in vitro."* Communicated by W. B. Hardy, Sec. R.S.

THURSDAY, JUNE 21.

CROONIAN LECTURE, by F. F. BLACKMAN, F.R.S. *The Problems of Plant Respiration considered as a Catalytic Process.*

In recent years much progress has been made in analysing the complex series of molecular changes that are summarised in the crude equation of respiration, $C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O$, and it is clear that catalytic enzymes of protoplasm are the specific agents determining the sequence and magnitude of these changes.

In this lecture an attempt is made to face the other aspect of respiration, which is peculiarly the problem of plant physiologists. This is the problem of the meaning of the varying intensity of respiration as shown in different nutritional states of activity of the same cell, in the different phases of dormancy, development and senescence, and in experimental conditions which lie outside natural experience.

Our knowledge of this wide subject is fragmentary, but a useful purpose should be served, for future research, by an attempt to examine these variations of respiratory intensity in terms of the factors which are known to affect the rate of activity of catalytic processes of the type studied *in vitro* as enzyme catalysis. These factors are (1) the amount of the catalytic agent, (2) the concentration of the substrate acted upon, (3) the presence of depressant substances which reduce the effective surface of the catalyst, (4) the influence of end products of activity as depressants of a similar nature, (5) hydrogen ion concentration controlling the dissociation of these amphoteric enzyme catalysts, and (6) dehydrating agents affecting the imbibition and water relations of the catalyst.

A complete formulation of biological variations of respiration in these physico-chemical terms is an ultimate goal of plant physiology; at present we are only at the beginning, determining the orientation of future researches.

The problem that may first be considered in some detail is the problem of the relation of respiration intensity of a cell to the concentration of the substrate, hexose sugar. Several isolated sets of data, bearing on this, are available. With plants in their natural existence this relation is intimately linked with another relation—that of the hydrolysis of starch to supply the substrate sugar or respiration. This is illustrated by

the starch-sugar balance of the cell and its significant variations with temperature.

In certain natural dormant conditions of vegetative organs, such as tubers, and in artificial starvation of active tissues, the concentration of hexose may be reduced *apparently to zero.* Respiration does not then cease, but is *maintained at a certain* definite minimal value. At this phase respiration passes out of its normal position of being merely the end link in a chain of floating carbohydrate catabolism, beneficially supplying energy for the service of metabolism, and becomes a devastating force. *Lacking the "protection" of carbohydrates,* nitrogenous substances now undergo *oxidation;* in this way the actual texture of protoplasm seems ultimately to be destroyed, and the end of vital organisation takes the form of sudden failure of the semi-permeability of the protoplast.

Variations of catalytic activity, by steady *seasonal drift, characterise the life-history* of individual plant organs. These are most marked in the phases of early development, of dormancy, and of senescence; here the experimenter has to face the difficulty that the essential efficiency of respiration may, under constant conditions, not be absolutely the same on any two successive days. *Some of these phenomena can be referred* to variations in the amount of catalytic agent, others may be due to the presence of depressants.

Variations of respiratory intensity may also be brought about by the accumulation of the end product, carbon dioxide, acting as a depressant of respiration. The *quantitative relations indicate that carbon dioxide* unites with the catalyst and lowers its effective activity, unless it can escape adequately by diffusion.

The whole of the relations of the catalytic system of plant respiration outlined above deal with normal conditions in which adequate oxygen concentration is *maintained at the active centres.* With *inadequate* oxygen the molecular sequence of changes undergone by sugar is deflected and there is set up a new system of relations, those of anaerobic respiration, which are at present also being explored quantitatively.

THE GEOLOGICAL SOCIETY OF LONDON.

JUNE 6.

The following communications were read:—

On a New Blattoid Wing from the Harrow Hill Mine, Drybrook (Forest of Dean), by HERBERT BOLTON, D.Sc., F.R.S.E., F.G.S.

The author describes a new type of fossil insect-wing found in shale on the waste-heap at the Harrow Hill Mine, and since recognised as being derived from the roof of the Coleford High Delf Seam. The specimen was discovered by students of the Imperial College of Science and Technology in the summer excursion of 1921.

Contact-Metamorphism in the Comrie Area of the Perthshire Highlands, by CECIL EDGAR TILLEY, PH.D., B.Sc., F.G.S.

Lantern-slides, etc., were exhibited by Dr. H. Bolton; and rock-specimens, microscope-sections, and lantern-slides were exhibited by Dr. C. E. Tilley, in illustration of their respective papers.

A meeting of the Society was held on June 20, when Dr. Herbert H. Thomas, M.A., V.P.G.S., gave a demonstration on "The Source of Origin of the Stones of Stonehenge."

The following communications were read:—

The River-Gravels of the Oxford District, by KENNETH STUART SANDFORD, B.A., F.G.S.

The Deposits of Paleocene Mammalia in Belgium, by PROF. LOUIS DOLLO, Sc.D., FOR.MEM.G.S., and PROF. P. TEILHARD DE CHARDIN, D.Sc.

PHYSICAL SOCIETY OF LONDON.

A meeting of the Society was held on Friday, June 22.

A lecture, entitled *The Excitation and Ionization Potentials of Gases and Vapours,* was delivered by PROF. F. HORTON, M.A., D.Sc., F.R.S., Royal Holloway College, University of London.

Proceedings at the meeting held on June 8, Alexander Russell, M.A., D.Sc., in the chair.

PROF. JAMES G. GRAY, D.Sc., F.R.S.E., Cargill Professor of Applied Physics in the University of Glasgow, delivered a lecture, entitled *A General Solution of the Problem*

of Finding the True Vertical for all Types of Marine and Aerial Craft. The lecture was accompanied by demonstrations with gyroscopes.

In the first part of the lecture it was shown that the difficulties presented by this problem arise from the horizontal accelerations which result from the turning of vehicles. A gyroscopic pendulum to succeed must possess a real precessional period, or a virtual precessional period during turning motion of the vehicle on which it is mounted, which is measured in hours.

Pioneer forms of Gray stabiliser were described. These were devised by the author and his brother for use in the Royal Naval Air Service. A system composed of a single gyroscope (mounted with its axis normally vertical) and an erector connected rigidly to one another, is pivoted to a gimbal frame by means of two cross pivots; and this frame is in turn attached by means of fore and aft pivots to uprights, or the equivalent, carried by the aeroplane. The system composed of the gyroscope and erector is mounted and balanced up so that the centre of gravity of the entire system coincides with the intersection of the pivot axes.

Various forms of erector made use of with these pioneer instruments were described, and their dynamical action discussed. One form consists of a circular track carried by the pivoted system, and so arranged that when the pivoted system is upright the track is horizontal. One, two, or more balls rotate on the track, each controlled by a pusher and a check carried by a member which rotates slowly (about 12 revolutions per minute) in the direction of spin of the gyroscope. When the system is upright the balls move round the track in contact with their pushers, and form a balanced system. When the system is inclined to the vertical the track is inclined to the horizontal, and each ball when ascending the slope of the track rests against its pusher, but after crossing the crest of the slope it is accelerated down the track and rests against its check. The motion of the balls relative to the pushers and checks results in the application to the pivoted system of an integral erecting couple.

It was shown how the contrivance could be arranged so that the stabiliser possessed the property that it was blind to the apparent vertical during turning motion of an aeroplane on which it was mounted, but conscious (so to speak) of the true vertical during the ordinary flight of the aeroplane.

These pioneer forms of the instrument were found to possess an accuracy, for bombing purposes, amounting to one-eighth or one-tenth of a degree, or about 20 feet on the ground from a height of 12,000 feet.

Previous work on the problem failed because the devices produced possessed the property that they left the true vertical quickly in the presence of the accelerations which accompany turning motions of the aeroplane, and returned to the true vertical only very slowly after the resumption of ordinary flight. The pioneer forms of Gray stabiliser (when properly used) moved only very slowly, if at all, towards the apparent vertical when the aeroplane was turning, and after the resumption of ordinary flight moved towards the true vertical (supposing an error to exist) relatively quickly.

Finally the latest forms of Gray stabiliser were described. These set themselves into the true vertical even when the vehicles on which they are mounted are turning, and this holds for all speeds of turning. Control is never lost. This result is obtained by constructing the apparatus so that a horizontal component of spin lies across the pivoted system, that is, parallel to the cross pivots. The pivoted system is mounted so as to be pendulous with respect to the pivots, and the direction of the horizontal spin, and its amount, is arranged so that when the vehicle turns there comes into existence a gyroscopic couple, applied about the fore and aft pivots, which is exactly equal and opposite to the so-called centrifugal couple applied to the pivoted system. Both couples are proportional to the angular speed at which the vehicle turns, and both change sign with that of the turning motion. Hence the compensation is correct for all speeds of turning.

This type of stabiliser, when fitted with special erectors, a simple example of which was described, supplies a complete solution of the vertical problem. Assuming an error made (small) in adjusting the compensating component of spin the resting position of the device is one in which it is inclined to the true vertical at a very small angle. The devices solve the problem completely for the rapid and slow turning movements of aeroplanes, and for the turning motions of ships.

DISCUSSION.

Sir James Henderson, after compliment-

ing Professor Gray on his lecture, referred to the great difficulties of the problem. These difficulties vary with the accuracy aimed at. If it be only required to maintain the vertical within one degree the problem is very easy, but if it be required to maintain it within one minute of arc the difficulties are very great, almost if not quite unsurmountable. The difficulties increase almost as the square of the accuracy aimed at.

Professor Gray had concentrated upon the problem of the bomb-dropping sight for aircraft, and had achieved considerable success during the war. The practical accuracy then aimed at in this connection was to maintain the vertical to about $\frac{1}{4}$ degree, and to this degree of accuracy Professor Gray had attained, as stated in his lecture.

The accuracy of any instrument of this type could be calculated accurately if the method of control were continuous. In Professor Gray's instrument the method of control involves a discontinuity which does not lend itself to easy computation. There are other methods of control, however, which are continuous and which enable accurate calculations to be made.

Professor Gray had said nothing in his lecture to give any idea of the amount of damping he employed. This determines the accuracy, because if the damping be very great the gyro follows the *virtual* vertical at corresponding rates and the deviation increases accordingly. On the other hand, if the damping be greatly diminished a considerable deviation arises from the rotation of the earth and a connection to the gyro-compass is required to compensate it. Thus when great accuracy is required the problem becomes excessively difficult.

Professor Gray's method of eliminating the effects of the centrifugal force during a turn was ingenious. If the speed adjustment be perfect, then any deviation which the pendulum has relatively to the vertical at the beginning of the turn turns azimuth with the plane. The deviations due to any change of velocity either fore or aft or during a turn are, however, not so easily compensated.

M. Paul Schilowsky said that naval experts ask for a degree of accuracy which must be the despair of gyroscopic inventors, but accuracy to a degree or half a degree of angle is by no means unattainable. He had tried a different solution from that given by the lecturer, viz., that of suspending the gyroscopic pendulum in neutral equilibrium on knife edges passing through its centre of gravity. In time, however, precession takes place with this arrangement, and the pendulum errs progressively from the true vertical. What is required is that the pendular suspension should be neutral for curved motion but stable for rectilinear motion. Sir James Henderson has designed an instrument for indicating the curvature of the path of the aeroplane. A combination of the two devices should make it possible to meet the requirement mentioned. The lecturer's plan was open to the objection that very rapid changes of rotary speed in the gyroscope would be necessary to compensate for the rapidity with which an aeroplane changes its linear speed. His admiration for the lecturer's work was sincere, and he should expect great results if the latter would take up the problem of altering the suspension of the gyroscope according to the curvature of the path.

Mr. T. Smith said that all present would have followed the lecture with the greatest interest. It was not easy, however, for those less familiar than the lecturer with the practical handling of gyroscopic apparatus to appreciate all the points at issue in the absence of a formal mathematical treatment. Possibly mathematical difficulties would arise from the discontinuities which had been mentioned by Sir James Henderson, but the modern methods for dealing with discontinuous quantities developed in connection with the quantum theory might perhaps give a hint as to the line of attack to be adopted in the present case.

The lecturer, in reply to the discussion, dwelt mainly on the point raised by M. Schilowsky, and claimed that his apparatus did become automatically "blind" during curved motion of the aeroplane in a manner satisfying M. Schilowsky's requirement. The effect of the earth's rotation on the gyroscope is very small provided the precessional period is long.

The President congratulated the lecturer on his solution of an important and difficult problem, and proposed a vote of thanks, which was carried with acclamation.

SOCIETY OF GLASS TECHNOLOGY.

The last ordinary meeting of the Society for the session 1922-23 was held in Leeds, on June 20. Prof. W. E. S. Turner, D.Sc., read a paper on "Specifications in the

Glass Industry." He pointed out that certain types of glass, such as that used for optical purposes, were bought on specification, and had to conform strictly to certain properties. In the enormous industry, however, which was concerned in the production of such things as containers for liquids and solids, no one seemed to have attempted to make or even purchase on this basis. Cases had arisen which had emphasised lack of precision. For example, a recent law case was fought round the quality of bottles supplied, and from the evidence it was quite evident that the actual quality of the glass did not seem to have been specified. Several other cases had arisen, pointing to the need of deciding to what specification different glass articles should conform. If the industry was to insist on furnace material makers providing refractories, to specification, then the glass manufacturers must show they were prepared to supply their goods to specification. Prof. Turner dealt with specifications which might be made the working basis for such articles as medicine bottles, beverage bottles, and other types of container.

MR. TH. TEISEN, B.Sc., contributed *Some Notes on the Design of Pot Arches*, his remarks being illustrated by lantern slides.

Criticising the old type of pot arch, Mr. Teisen said the flue outlet for burnt gases at the back wall near the bottom gave cold pockets inside the furnace. On the other hand, the ensuing lack of proper heat distribution could be somewhat helped by longer soaking. The fire boxes being open, the fire itself was not under proper control.

The Continental type, with direct fired furnace, fire-box below, combustion flues and air flues leading to the uptake at the back of the chamber, and fumes passing through holes in the floor near the front and thence to the chimney, was better but not so practical. With the entry of the gas-fired pot furnace in the glass industry, a demand had arisen or a more modern type for heating pots. That type should contain better facilities for heat distribution and control; it should also combine good conditions for working and firing with easy installation and economy of space. A gas-fired recuperative pot-arch, designed on these lines some years ago, and which proved a success, was described, as well as a pot-arch at Messrs. Moncrieff's, where, during the first stage of burning, a low fire was kept on the grate, fed through the ash door. The secondary air slide was closed, and the furnace was in other ways directly-fired. For the purpose of driving out natural and combined water without producing surface cracks, water was kept dripping on the firebars, as well as on a plate arranged in front of them, thereby producing a certain amount of steam, which helped to retard a too quick drying of the surface parts and allowed the inside to evaporate its moisture at the same rate as the outside. The steam produced made it necessary to run with the usual density of smoke. That type took up little space with proportionately less building cost, and results in practice were quite satisfactory.

MR. S. ENGLISH, M.Sc., gave a paper entitled *Notes on the Ashley Bottle Machine*. He remarked that to one familiar only with modern glass forming machines, it might be surprising to hear that the home of bottle making machinery was on this side of the Atlantic, but such was the case, and it was only after the possibility of making narrow mouth bottles satisfactorily by machines had been proved here, that such bottle making machinery was introduced in America. The first machine to make narrow mouth bottles at all satisfactorily was designed and built by H. M. Ashley in Yorshire. About 1866, Josiah Arnall, postmaster at Ferrybridge, conceived an idea which would enable bottles to be blown by machinery. He submitted his idea to a bottle manufacturer, but apparently it was too crude or too revolutionary. Nearly twenty years later, H. M. Ashley, the manager of an iron foundry near the post office, went to live with Arnall, and there can be no doubt that Arnall discussed with Ashley his ideas concerning the possibility of blowing bottles by machinery.

As a result of such discussion, Ashley built an experimental machine in which glass was poured into an inverted mould, which was fitted with a plug to form the inside of the neck and with a movable top plunger. When a charge of glass had been placed in the mould, the sliding plunger was brought down on top of it, thus pressing it down around the fixed plug and forming the neck. Compressed air was then admitted through the plug, blowing up the bottle and at the same time raising the sliding plunger, to the desired extent. Such an arrangement was very simple, and was naturally unsuccessful, but it had sufficient good points to cause Ashley to try to develop it into a useful machine. The first

step in its improvement appeared to have been an appreciation of the fact that three moulds were necessary, one for forming the neck of the bottle, the second for giving a preliminary form to the main body of the glass, and the third for blowing the finished bottle. This provision of a ring mould, parison mould and blow mould was the foundation on which all Ashley's experimental machines were built, and has been incorporated in every successful machine since.

MINERALOGICAL SOCIETY.

June 19.

Dr. A. Hutchinson, F.R.S., President, in the chair.

Dr. L. J. Spencer (with chemical analyses by E. D. Mountain): *New copper-lead Minerals from the Mendip Hills (Somerset).*

Mendipite ($2PbO.PbCl_2$), which occurs as crystalline nodules in manganese-ore, is recorded from new localities. *Chloroxiphite* ($2PbO.Pb(OH)_2.CuCl_2$) as green monoclinic blades resembling epidote, and *Diaboleite* ($2Pb(OH)_2.CuCl_2$) as bright-blue tetragonal plates resembling boleite, both occur embedded in the mendipite. Hydrocerussite ($2PbCO_3.Pb(OH)_2$) is abundant, sometimes as large crystals (*i.e.*, crystallised "white lead"). Crednerite ($CuO.Mn_2O_3$) forms fan-like aggregates of thin plates. Pyromorphite, which some centuries ago was evidently an important ore of lead in the Mendips, has been preserved (together with mendipite, hydrocerussite, etc.) in the Woodwardian collection (1728) at Cambridge. Wulfenite and mimetite have been found at Higher Pitts, near Priddy. The various minerals show progressive stages of alteration with some well-marked pseudomorphs: mendipite → hydrocerussite → cerussite; chloroxiphite → hydrocerussite + malachite I cerussite + crednerite → malachite II.

W. F. P. McLintock: *On a petalite-bearing Rock from Devonshire.*

The well-known aplite from Meldon, in Devonshire, is shown to have developed in certain parts of the intrusion a soda-lithia phase rich in the rare lithium-aluminium silicate, petalite. This mineral, not previously known from Britain, occurs as one of the final products of consolidation of the aplite either in coarse-grained veins of pegmatite, associated with quartz, orthoclase, albite, a lithia-bearing mica, tourmaline, and apatite, or as irregularly-shaped masses throughout the rock itself. The petalite gives rise by decomposition to the pink clay, montmorillonite, so well-known from this locality. Certain other veins, free from petalite, are also present, the most interesting constituents of the rarer types being prehnite, axinite and a pleochroic cordierite. The apatite in the aplite is shown to be a pneumatolytic mineral, occurring not only in the rock as ophitic patches enclosing quartz and felspar, but also impregnating certain xenoliths of peculiar type. Deep-blue crystals developed in the druses of a coarse grained modification of the aplite and associated with pink, yellow, and green tourmaline, are described.

A. Brammall and H. F. Harwood: *The accessory Minerals of the Dartmoor Granite.*

The complete list of minerals identified by the authors is as follows: Biotite and muscovite; tourmaline, topaz, fluor; zircon, apatite, monazite, garnet, sphene, and pale amphibole (edenite); ilmenite, magnetite, pyrites, pyrrhotite, and molybdenite; gold and silver; rutile, brookite, anatase, cassiterite, and specular iron ore; barytes and allanite; andalusite, sillimanite, cordierite, spinel, and corundum. Tourmaline originated at two stages in the cooling history of the intrusion: (1) pre-solidification—primary and secondary; (2) post-solidification—secondary. The more severe and widespread pneumatolysis and the lodes are referred to a post-solidification stage.

Seitaro Tsuboi: *Optical dispersion of Three Intermediate Plagioclases.*

The principal refractive indices, α, β, γ, of (1) oligoclase from Hawke Mine, Bakersville, North Carolina; (2) andesine from Maeyama, Shinano, Japan; and (3) labradorite from County Down, Ireland, for light of 9 different wave-lengths (700, 671, 644, 610, 589.3, 554, 535, 527, 508.5$\pi\pi$) were determined. The optical orientations of the first and the third of the above three felspars, for light of 5 different wave-lengths (700, 644, 589.3, 535, 508.5$\mu\mu$) were also determined.

SEITARO TSUBOI: *A Dispersion Method of Determining Plagioclases in Cleavage-Flakes.*

This new method is based on the principle of H. E. Merwin's improved immersion method. By means of a diagram a quick and exact determination of plagioclases is possible. It is applicable to such small crystals as are common in rocks.

C. S. GARNETT: *The "Toadstone-clays" of Derbyshire.*

The olivine-dolerites ("toadstones") of Derbyshire under two types of alteration: (1) by ordinary weathering to limonite or ochreous deposits; (2) in the absence of oxidising agents under a limestone covering, they may pass through dolerite-greenstone and "green-earth" to a greenish-white or almost white clay ("toadstone-clay") with the composition $2Al_2O_3.6SiO_2.3H_2O$.

DR. G. T. PRIOR: *The Meteoric Stone which was seen to fall at Ashdon, near Saffron Walden, Essex, on March 9, 1923.*

The stone, which weighed about 1,300 grams, is a white chondrite showing on one face well-marked radiating lines of flow of the fused crust.

DR. G. T. PRIOR: *The Sinai Meteorite.*

The meteoric stone of 1,455 grams which was seen to fall near Kantarah, in the north of the Sinai Peninsula, in July, 1916, is an intermediate hypersthene-chondrite, having a percentage of nickeliferous iron of about 8.6, in which the nickel amounts to about 15 per cent.

G. GREENWOOD: *Communications from the Crystallographic Laboratory of the University of Manchester. No. 1: The Detection of Rotatory Polarisation in an Orthorhombic Crystal exhibiting Crossed Axial Dispersion.*

A plate perpendicular to the acute bisectrix of a crystal of tri-phenyl-bismuthine dichloride, when in the extinction position, transmits a brilliant green monochromatic light due to circular polarisation.

A. F. HALLIMOND: *The Chemical Classification of the Mica Group I.—The Acid Micas.*

THE COLOUR USERS' ASSOCIATION.

The Annual Meeting of The Colour Users' Association was held at The Milton Hall, Deansgate, Manchester, on June 19, Mr. H. Sutcliffe Smith presiding.

Throughout the year many conferences had been held between the users' representatives of this Committee and the Council, at which difficulties and grievances had been discussed with beneficial effect. Applications on the ground of superiority of foreign quality were now dealt with expeditiously. The chief difficulty was with regard to applications because of price differences. The Licensing Committee officially informed the Association on September 30 last that, as a temporary measure, applications would be granted where the British prices were more than three times pre-war level and where higher than the current foreign prices. When an application was made for a licence the user had to state the price at which he could buy the foreign colour. If the colour could be made in this country, the British makers were given the opportunity of taking the business at the foreign price quoted, or at three times pre-war price, whichever was the higher. If the makers could not accept the order on this basis, then a licence was granted to the users to import. It was understood, however, that the makers' representatives on the Licensing Committee only agreed to meet this foreign price competition provided financial assistance was furnished to the dye manufacturers by the Government. The makers definitely state they cannot at present bring their prices down to three times pre-war level without financial assistance.

PRICES OF DYEWARES.

The import prices of dyes and dyestuffs, as recorded in the Board of Trade Returns, are at a very high level. For finished Coal Tar dyestuffs (exclusive of Indigo and Alizarine), the following are the averaged prices per pound: 1913, 1s. 7d.; 1920, 79s. 2d.; 1921, 66s. 7d.; and 1922, 65s. 9d. Many conferences have been held throughout the year with the makers and with the Board of Trade on this subject. The users' request to reduce prices to 200 per cent. above pre-war was not an unreasonable one, but the makers had stated that without financial assistance they could not possibly get down to a basis selling price of a maximum of three times pre-war. The

whole cost of establishing the dye-making industry in this country was now being borne by the users. There was a further serious aspect of this situation which required to be considered, and that was the effect of the high prices of British products upon the prices of foreign colour sold in this country. The British makers were not the sole beneficiaries of these high prices, for the foreign producer undoubtedly took full advantage of the artificial condition of the British market consequent upon the Prohibition Act.

Reparation Dyestuffs.

A deputation from the Council had had an opportunity of visiting the official in charge of the dyestuffs section of the Reparation Commission in Paris. Germany furnished a list monthly of 25 per cent. of its output, which was available for the Allies, who were, within a stipulated period, required to indicate the quantities of colours they desired according to agreed proportions. This country's share was about 4 per cent. of the 25 per cent. It was found, in practice, however, that the U.K. proportion of 25 per cent. of Germany's output of a great many special types of dyes was short of this country's actual needs; on the other hand, there were large quantities of dyestuffs available which were of no interest to us. After several conferences, it was arranged that the German makers should supply more than 25 per cent. of specific dyes on Reparation Account, provided that quantities were not taken in excess of the home consumption, that the export prices were credited to Germany for all quantities above 25 per cent. of each specific dyeware, and that the total quantities were not in excess of 25 per cent. of Germany's total production stipulated under the Committee. At the begining of each quarter, the Allies were called upon to lodge with the German makers particulars of their requirements under this new arrangement, whereby the German makers would make certain specific colours, which were charged on the following basis:

50 per cent. at the world's lowest price (generally the internal German price).

50 per cent. at the lowest price the I.G. shall have sold at in the receiving country during the month preceding the month of delivery, or during the month of delivery, whichever is the lower.

The users consider this new arrangement of considerable advantage to them, in that it is a satisfactory means of obtaining through reparation, colour either not made here or not made in adequate quantities.

Unfortunately, however, the price ruling in this country which regulates 50 per cent. of the quantities so imported is an arbitrary one, since, if the bulk of the colour is taken under Reparation, there is no competitive market; the result is that the I.G. can charge such a figure for 50 per cent. of the colour as the resultant average with the remainder at the internal German price gives them a substantial overall selling price. The Association was in close contact with the officials in charge of Reparation dyestuffs in Paris, and it was hoped to bring before them more adequately the users' needs and requirements at regular intervals, and in such a form as would be of practical assistance to them in the taking over of Reparation colour. According to the information furnished by the Board of Trade, it was obvious that this country was not making the fullest use of the facilities afforded by the Reparation Committee, and he would suggest that the whole procedure of obtaining Reparation dyestuffs should now be reviewed in the light of the experience of the past two years.

Pricing of Reparation Dyestuffs.

Upon several occasions it had been stated in the House of Commons that prices had been revised from time to time by representatives of the Colour Users' Association. This was not quite in accordance with the actual facts. The Association had protested on many occasions against the high prices of Reparation dyestuffs, and they had had considerable correspondence with the Board of Trade upon the subject.

British Dyemakers.

At the last annual meeting he submitted three distinct suggestions bearing on the establishment of the dye making industry with particular reference to the British Dyestuffs Corporation, Limited, namely:—(1) That the Government should wipe out their loan to the Company; (2) that the Company should face a scheme of reconstruction; (3) that the Directors should eventually see their way to arrange that the Corporation shall be managed by men who have been brought up in the industry, on the lines of the big textile associations.

Much progress had undoubtedly been made by this Corporation in the variety and types of the colours which they now

made, and in the improvement in their quality, but there was considerable dissatisfaction among the users on the question of high prices. He wanted to make it perfectly clear that the users did not ask the makers to bring their prices down to the general economic price level, but the makers stated they could not effect any further reductions without serious losses.

FOURTH INTERNATIONAL CONFERENCE ON PURE AND APPLIED CHEMISTRY.

The Fourth International Conference on Pure and Applied Chemistry was held from June 18 to 20 at Cambridge. Various reports were presented, and four scientific communications were received and discussed.

Among the matters considered were the reforms in the nomenclature of inorganic and organic chemistry, and the compilation of tables of constants.

Certain matters of importance in industrial chemistry, such as the preservation of foodstuffs, and standardisation in various chemical industries were discussed.

PROF. J. W. McBAIN, F.R.S., read a paper on *The Study of Soap Solutions and its bearing upon Colloid Chemistry.*

The author pointed out that the study of soaps has so many ramifications, and the phenomena met with are so manifold, that it is only by the exercise of the severest restriction that a clear, general picture can be obtained. Soaps, nevertheless, lend themselves particularly to a study of the colloidal condition and its relation to other states. He dealt with the properties of fluid solutions and clear transparent jellies in the state of complete true reversible equilibrium.

Dilute soap solutions are ordinary crystalloids, whereas more concentrated ones are colloidal electrolytes. Excess of soap above a saturation alue separates out in the form of true crystals. The transparent jellies are confined to a portion of the region in which the soap is a colloidal electrolyte. Many soap solutions afford examples of anisotropic liquids.

DR. E. K. RIDEAL read a paper on *Recent Developments in Contact Catalysis.* It is now generally admitted that contact catalysis proceeds through actual contact of the reactants with the catalytic material, although the actual mechanism by which reaction is caused may be brought about by means other than molecular collision, such as radiation or electron transfer. The author discussed diffusion as a factor in catalytic change, the influence of poisons on catalysts, the nature of adsorption compounds, promoter action, etc.

PROF. J. F. THORPE read a paper by himself and DR. C. K. INGOLD on *Some New Aspects of Tautomerism,* in which he defined the term tautomerism and dealt with 1 tautomerism involving the movement of a hydrogen atom and 2 tautomerism which does not involve this movement. The report was based upon the authors' own contributions on the subject.

Prof. F. G. Hopkins gave a report on the Mechanism of Oxidation in the Living Body. He reviewed the previous work on this subject, and drew attention to the problems encountered.

These reports were discussed at sittings of the confeience.

CORRESPONDENCE.

ANALYSIS OF ANCIENT BRONZE.

To the Editor of THE CHEMICAL NEWS.

SIR,—Analysis of several bronze relics dating to the Phœnician and Assyrian periods refute the belief that the bronzes of this time, in some cases, were artificial. The unequal distribution of the constituents coupled with the presence of extraordinary impurities show considerable indications of unaltered constitution through castings.

A comparison between an alloy-ore mined (according to ancient records) at Tel-el-Sifr in South Chaldea (*ca.* 1500 B.C.) bears considerable similarity to that mined recently in the same locality, showing a general average content of 99.5 per cent. Cu., 0.2 per cent. P., 0.04 per cent. Sn., and traces of As, Bi, Fe, Co, Ni, S and N. That produced from Cyprus (*ca.* 3500 B.C.) contains less copper and more tin. The proportions, however, are such as to suggest the original natural forms.

These observations may be supported by the following three Biblical references:—

(1) Gen. VI., 22: "And Zillah, she also bare Tubal-cain, an instructor of every artificer in brass and iron." (3870 B.C.).

(2) Deut., VIII., 9: "A land whose stones are iron, and out of whose hills thou mayest dig brass." (2600 B.C.).

(3) Job., XXVIII., 2: "Iron is taken out of the earth, and brass is molten out of the stone." (856 B.C.).

Yours faithfully,
F. E. LIECHTI.

Church Crookham, Hampshire.
June 16, 1923.

NOTICES OF BOOKS.

Qualitative Organic Analysis—An Elementary Course in the Identification of Organic Compounds, by OLIVER KAMM. Pp. VII. + 260. London: Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, W.C.2. 1923. 12s. 6d. net.

The multiplicity of elementary practical manuals on Organic Chemistry is such that a new volume on this subject needs to exhibit some outstanding feature in order to justify its existence.

In the preface of this new American publication on the subject the author states that in 1905 practical organic chemistry was taught in only two or three universities, but in 1918 it was prescribed for all colleges undertaking the training of chemists under the supervision of the U.S. Government.

The course outlined in Prof. Kamm's work follows that which he adopted himself at the University of Illinois, and has for its basis the analytical methods of Prof. Mulliken. It is arranged to cover 32 laboratory periods of 3 hours, and includes the usual experimental work done by students in colleges and technical institutes in qualitative organic derivatives and quantitative analysis. There are also short chapters on the preparation of characteristic exercises.

The book should form a useful guide to lecturers and demonstrators, and will doubtless be adopted by some as a class textbook.

Klinisches Kolloidchemie, von DR. ERNEST JOEL. Pp. 124. Dresden and Leipzig: Verlag von Theodor Steinkopff. 1923. Price 2s. 2d.

Dr. Joel's volume on the clinical applications of colloid chemistry is based upon a course of nine lectures delivered by him on this subject. The lectures and the book are both primarily intended for advanced students and specialists. It is interesting to note how wide are the applications of such an apparently academic subject as colloid chemistry. The author has applied the physico-chemical theories of colloid gel formation and of swelling to the problems of the medical practitioner, for whom much of the book will probably be new.

Prof. K. Spiro, of Basle, has contributed a foreword drawing attention to the coming importance of a knowledge of the applications of colloid chemistry.

The Department of Glass Technology of Sheffield University has published Volume V. of the *Experimental Researches and Reports* which have been collected from the *Journal of Glass Technology*, in which publication they have appeared during the year.

These Reports are collected from the work of Prof. Turner and his collaborators, and include papers on the action of various analytical reagents on glassware, the action of water and steam under pressure on some soda-lime-silicate glasses; and some contributions to the science of glassmaking, and a few articles of a more general type.

The paper on the present position of the glass industry in Czecho-Slovakia is a very discerning one, but it is regrettable that the Czech currency is persistently called kroner instead of kronen. This is perhaps a small point, since the volume contains much that is of considerable value and interest.

BOOKS RECEIVED.

The Synthetic Dyestuffs and the Intermediate Products from which they are derived, by JOHN CANNELL CAIN, D.Sc., and JOCELYN FIELD THORPE, C.B.E., D.Sc. Pp. XV. + 423. Sixth Edition. 1923. Messrs. Charles Griffin & Co., Ltd., Exeter Street, Strand, W.C.2. 21s. net.

Uber Naturprodukte, by MAX HONIG. Pp. X. + 181. 1923. Verlag von Theodor Steinkopff, Dresden und Leipzig. Price 4s. 4d.

Atomic Structure and Spectral Lines, by ARNOLD SOMMERFELD, translated by HENRY

L. BROSE, M.A. Pp. XIII. + 626. Third Edition. 1923. Messrs. Methuen & Co., 36, Essex Street, W.C.2. 32s. net.

The Mellon Institute of Industrial Research of the University of Pittsburgh has just issued its tenth annual report, explaining its objects and achievements.

The Ministry of Agriculture & Fisheries has issued a leaflet, No. 114, entitled, *The Scientific Principles of Feeding Poultry.*

PUBLICATIONS RECEIVED.

Bulletins published by the U.S. DEPARTMENT OF THE INTERIOR:—

504: *Surface Water Supply of the United States*, 1919-1920. *Part IV.—St. Lawrence River Basin.* By NATHAN C. GROVER, W. G. HOYT, C. C. COVERT and C. H. PIERCE. Pp. 188.

729: *Oil Shale of the Rocky Mountain Region.* By DEAN E. WINCHESTER. Pp. 204.

734: *Deposits of Manganese Ore in the Batesville District, Arkansas.* By HUGH D. MISER. With a chapter on the mining and preparation of the ores, by W. R. Crane. Pp. 271.

735 i.: *Diamond-bearing Peridotite in Pike County, Arkansas.* By HUGH D. MISER and CLARENCE S. ROSS. Pp. 279-322.

735 j.: *The los Burros District, Monterley County, California.* By JAMES M. HILL. Pp. 323-329.

751 A.: *Continuity of some Oil-bearing Sands of Colorado and Wyoming.* By WILLIS T. LEE. Pp. 22.

I.29: *Summary of Mineral Production in Foreign Countries*, 1919 *and* 1920. By L. M. JONES. Pp. 513-564.

I. 30: *Iron Ore, Pig Iron and Steel in* 1921. By ERNEST F. BURCHARD and HUBERT W. DAVIS. Pp. 565-597.

II. 1: *Fuel Briquets in* 1922. By W. F. McKENNEY. Part II. Pp. 4.

Revision of the Flora of the Green River Formation with Descriptions of New Species. By F. H. KNOWLTON. Pp. 133-182.

Fossil Plants from the Tertiary Lake Beds of South-Central Colorado. By F. H. KNOWLTON. Pp. 183-197.

The Fauna of the So-called Dakota formation of Northern Central Colorado and its Equivalent in South-Eastern Wyoming. By JOHN B. REESIDE, JUN. Pp. 199-207.

PUBLICATIONS RECEIVED FROM THE U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF MINES.

The Universal and the Fireman's Gas Masks, by S. H. KATZ, J. J. BLOOMFIELD, and A. C. FIELDNER. Pp. 22.

Metal-Mine Accidents in the United States during the Calendar Year 1921, by WILLIAM W. ADAMS. Pp. 96.

The Chloride Volatilisation Process of Ore Treatment, by THOMAS VARLEY, E. P. BARRETT, C. C. STEVENSON, and ROBERT H. BRADFORD. Pp. 99.

Bibliography of Petroleum and Allied Substances in 1919 *and* 1920, by E. H. BURROUGHS. Pp. 374.

Preparation, Transportation, and Combustion of Powdered Coal, by JOHN BLIZARD. Pp. 127.

The Dominion Bureau of Statistics, Canada, has just published a report entitled *Chemicals and Allied Products in Canada*, 1921. It contains a summary of the statistics on the production of chemicals in Canada during the year.

From a perusal of these statistics in the various chemical industries, it is noticed that production in almost every industrial field during the past three years shows the effect of post-war influences. In 1919, as a result of the large scale production during the war years, the accumulation of stocks was considerably in excess of current requirements, with the result that production was much curtailed. Most of these stocks were disposed of in 1919 with the result that in the early part of 1920 an appreciable advance in prices occurred which reached a maximum about the middle of the year. This advance was followed by increased production in many industries. During the closing months, however, demands from consumers for lower prices became more insistent, and in 1921 a deflation in prices occurred. At the close of that year, although prices were at a much lower level than at the beginning, conditions through-

out the industry were much improved, and prospects were much better.

An illustrated catalogue of Astronomical Photographs, including lantern slides, transparencies, and prints from negatives made at the Yerkes Observatory, has just been issued. It is the third edition of this catalogue issued by the University of Chicago Press.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

13835—Cosway, H. C.—Manufacture of methyl chloride and ethyl chloride. May 25.

13752—Metals Production, Ltd.—Leaching copper. &c. May 24.

13502—Oderberger Chemische Werke Akt-Ges.—Production of colloidal solutions and re-soluble dried residues from irreversible colloids. May 22.

14501—Chemische Fabrik Griesheim-Elektron.—Manufacture of azo-dyestuffs. June 1.

14268—Brutkzus, M.—Process for effecting chemical reactions. May 30.

14079—Chemische Fabrik auf Action vorm E. Schering.—Manufacture of barbituric-acid compounds. May 28.

14293—Grasselli Chemical Co.—Manufacture of concentrated acetic acid. May 30.

14013—Green, H.—Reduction of oxides and oxy-compounds. May 28.

14325—Jaques, A.—Manufacture of barium sulphate. May 31.

14672—Chemische Fabrik Griesheim-Elektron.—Manufacture of acylacetyl compounds. June 4.

14945—Soc. of Chemical Industry in Basle.—Manufacture of naphthioindoxyls. June 7.

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183419—National Aniline & Chemical Co., Inc.—Production of vat dyes.

197573—Marks, E. C. R.—Zirconium alloys and and Hirschberg, Z. von.—Manufacture of processes of making same.

182781—Deutsch-Englische Quarzschmelze Ges., quartz and the like articles non-pervious to gases.

197706—Meter, J. W. van.—Method of producing poisonous gases.

197724—Pease & Partners, Ltd., and Stephenson, G.—Manufacture of sulphate of ammonia.

197845—Prentice, A. T.—Method of and apparatus for burning sulphate.

197898—Rhenania Verein Chemischer Fabriken Akt-Ges.-Zweigniederslassung Mannheim and Rusberg, Dr. F.—Manufacture of alkali thiosulphate.

Abstract Published this Week.

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